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Taylor, W.K. 1976. Migration of the common yellowthroat with an emphasis on Florida. Bird Banding 47(4):319-332.

Tessen, D.D. 1980. Western Great Lakes region. American Birds 34(6):898.

Thom, R.H. 1968. 468. Bird Haven Sanctuary, Ill. Audubon Field Notes 22(2):267.

______. 1973. Notes on the birds of Hidden Springs State Forest. Audubon Bulletin 166:33-40.

Thompson, C.F., and V. Nolan, Jr. 1973. Population biology of the yellow-breasted chat *(Icteria virens* L.) in southern Indiana. Ecological Monographs 43(2):145-171.

Thompson, M.D. 1958. The 1959 [= 1958] breeding bird census. Audubon Bulletin 108:5-11.

______. 1960. 1959 nesting report. Audubon Bulletin 115:7-13.

______, and O. Robinson. 1963. Illinois nesting records—1962. Audubon Bulletin 126:7-15.

Tuttle, H.E. 1918. Notes on the nesting of the Nashville warbler. Bird-Lore 20(4):269-272.

Twomey, A.C. 1945. The bird population of elm-maple forest with special reference to aspection, territorialism and coactions. Ecological Monographs 15(2):173-205.

Van Duzen, E. 1920. Notes from Rockford. Audubon Bulletin Fall:24.

Van Horn, D.H. 1952. Breeding-bird populations of flood plain and upland forests in central Illinois. M.S. Thesis. University of Illinois. 78 p.

Wade, S, 1916. Mid-May bird census, 1916. Wilson Bulletin 28(2):82.

Walkinshaw, L.H. 1953. Life-history of the prothonotary warbler. Wilson Bulletin 65(3):152-168.

Walter, H.E., and A.H. Walter. 1904. Wild birds in city parks. A.W. Mumford, Chicago. 40 p.

Wandell, W.N. 1948. Agricultural and wildlife values of habitat improvement plantings on the Illinois black prairie. North American Wildlife Conference Transactions 13:256-270.

Wasson, I.B. 1957. Effect of cold spring of 1956 in Chicago area. Audubon Magazine 59(1):4.

Westcott, C. 1970. 488. Barrington, Ill. Audubon Field Notes 24(2):305-306.

Wheelock, I.G. 1905. Regurgitative feeding of nestlings. 22(1):54-71.

White, J.S. 1930. Chicago region. Bird-Lore 32(3):210-212.

Widmann, O. 1885. Note on the capture of *Coturniculus lec* and *Dendroica kirtlandi* within the city limits of St. L Mo. Auk 2(4):381-382.

______. 1895. Swainson's warbler an inhabitant of the swa woods of southeastern Missouri. Auk 12(2):112-117.

______. 1897*a*. The myrtle warbler, *Dendroica coronata* Missouri in summer. Osprey 2(3):40.

______. 1897*b*. The summer home of Bachman's warbler no l unknown. Auk 14(3):305-309.

______. 1898. Bachman's warbler in summer. Osprey 3(1):1

______. 1907. A preliminary catalog of the birds of Miss Academy of Science of St. Louis Transactions 17(1). 288 p.

______. 1922. Extracts from the diary of Otto Widmann. Louis Academy of Science Transactions 24(8):1-77.

Wilhelm, E.J., Jr. [1957]. Birds of the St. Louis area. St. Audubon Society. 40 p.

Wilkoski, W. 1924. A wanderer's bird notes. Oologist 41(5)

Williams, Z.A. 1975. Three-year study of bird life at Wil Prairie Park, Peoria, Illinois. Peoria Academy of Science ceedings 8:9-15.

Willson, M.F. 1974. Avian community organization and ha structure. Ecology 55(5):1017-1027.

Wilson, B.H. 1904. An all day bird study. Wilson Bul 16(2):51-52.

______. 1906. The birds of Scott County, Iowa. Wilson Bul 18(1):1-11.

______. 1912. Red-letter days in the country. Oologist 2 281-285.

Woodruff, F.M. 1907. The birds of the Chicago area. Chi Academy of Sciences Natural History Survey Bulletin 6. 221

Wright, E.G. 1926. Spring birds of a city park. Ool 43(2):28.

Wuestenfeld, H. 1977. Bird finding. Pere Marquette State Jersey County. Illinois Audubon Bulletin 182:25-26.

Yeager, L.E. 1949. Effect of permanent flooding in a river-bo timber area. Illinois Natural History Survey Bulletin 2 33-65.

US ISSN 0073—490X

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HE FATE OF LAKES
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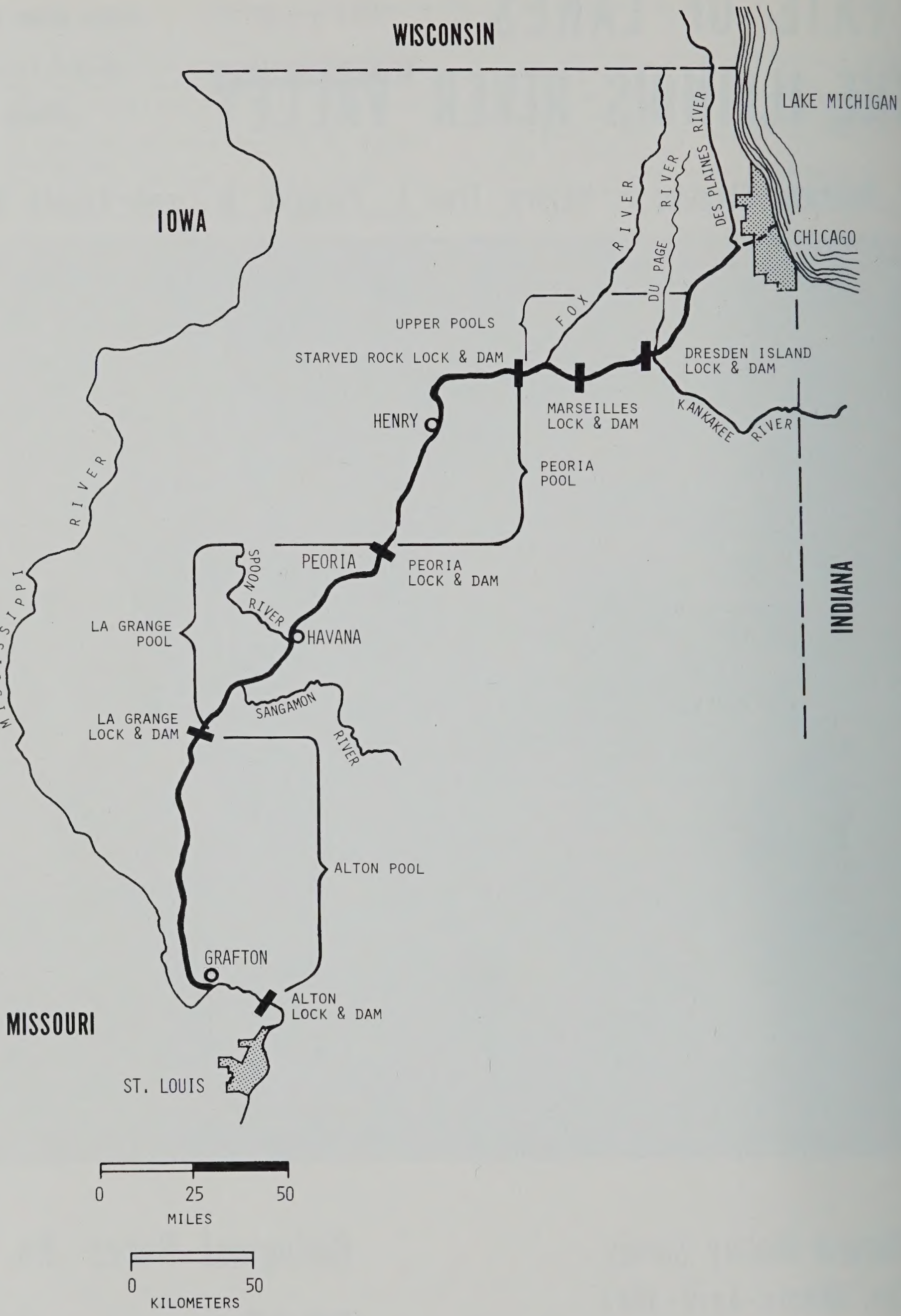

Fig. 1.—The Illinois River valley and its designated navigation pools.

Cover photograph.—Lateral bottomland lakes along the Illinois River channel north of Chillicothe. (Cover design by Mary Beth Kidd.)

The Fate of Lakes in the Illinois River Valley

Frank C. Bellrose, Stephen P. Havera,
Fred L. Paveglio, Jr., and Donald W. Steffeck

Today, the appearance of the Illinois Valley is a far cry rom its appearance in the early 1900's. A glimpse of its near-pristine condition is available in sketchy historical accounts, in old photographs, and in maps prepared by J. W. Woermann between 1902 and 1904 for the U.S. Army Corps of Engineers, Chicago Office. Woermann made wonderfully detailed maps of the river, its lakes, and the loodplain as far back as the valley bluffs.

Using the Woermann maps as a base, we compared the physical nature of the bottomland lakes and the adjacent loodplain of the Illinois Valley in the early 1900's with present conditions and projected our analyses into the early 21st century. This paper is an extension of an earlier report Bellrose et al. 1979) that evaluated the effect of sedimentaion on waterfowl food plants and waterfowl populations.

We examined the status of bottomland water areas because they formed the basis for one of the great inland ommercial and sport fisheries as well as for unexcelled waterfowl hunting. Unfortunately for fish and wildlife, the akes and lesser bottomland water areas have changed drastically in the ensuing 80 years as man has expanded his ultural activities.

ACKNOWLEDGMENTS

Kathleen Archer assisted in the measuring of water reas by planimeter and the analysis of data. Harold Henderson also measured many lake areas by planimeter. Dr. Kenneth S. Lubinski aided in computer programming. Three experts in particular disciplines reviewed the paper nd made constructive suggestions: Dr. Ming T. Lee, Associate Engineer, Illinois State Water Survey; Dr. David L. Gross, Associate Geologist, Illinois State Geological urvey; and Dr. Richard E. Sparks, Aquatic Biologist, llinois Natural History Survey.

This study developed as part of contract MOU 78-1 inanced by the Chicago District, Corps of Engineers, U.S. Army, under the supervision of Paul Morhardt, Chief of Engineering, and Edward H. Hanses, Chief of Environmental Resources (Havera et al. 1980).

Vicky Atchley typed the tables and manuscript. Lloyd Le Mere, Technical Illustrator, drew the graphs. Dr. Glen C. anderson, Head, Section of Wildlife Research, and Eva teger did preliminary editing. Final editing and preparation of the paper for publication were done by Robert M. Zewadski, Technical Editor.

We thank Mr. Charles C. Haffner, III, Mr. and Mrs. Gaylord Donnelley, the Wildlife Management Institute, and the Max McGraw Wildlife Foundation for contributions toward the cost of publication.

METHODS

The surface areas of the bottomland lakes in the Illinois River valley have been determined a number of times (Mills et al. 1966:5; Lee & Stall 1976; Bellrose et al. 1977:C-3). In this report we have compiled data for the surface areas of the lakes that now exist in the Illinois Valley. We have used the best available sources and field data collected during the summers of 1976–1979. We have also determined the potential surface areas of mud flats and the volume and sedimentation of selected bottomland lakes.

We examined the Illinois River valley by navigation pools: the upper pools, consisting of Dresden Island, Marseilles, and Starved Rock; Peoria Pool; La Grange Pool; and Alton Pool (Fig. 1).

The surface areas of the bottomland lakes were determined from five sources. The first source was the 1902–1904 Woermann maps. The second source was base maps of the Illinois River made by the U.S. Army Corps of Engineers in 1933. These maps were used sparingly because of the landscape changes that have occurred in the valley since their completion. Our third source of information was the aerial photo maps in the 1969 Report for Recreational Development by the Illinois Division of Waterways and Illinois Department of Conservation. The fourth reference used was a series of color aerial photographs taken in 1974 by the Chicago District of the U.S. Army Corps of Engineers. These photographs were not rectified; therefore, the scale of the picture was determined for each lake examined. The fifth source was a map recording soundings of Upper Peoria Lake made by the U.S. Army Corps of Engineers in 1976.

The surface areas of the water bodies on the Woermann maps, the 1969 Recreational Development maps, and the 1974 aerial photographs were measured with a compensating polar planimeter. Surface areas were measured in acres, rounded to the nearest whole unit, and converted to hectares. Data from these measurements were used to evaluate the effects of diverted water, levee districts, and dams on bottomland water areas from 1903 to 1974.

We conducted field work from 1976 to 1979 to determine the volumes of selected bottomland lakes. Because of their sizes and locations, 21 representative bottomland lakes were selected for volume analyses. Eight lakes were studied in Peoria Pool, 11 in La Grange Pool, and 2 in Alton

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This paper is published by authority of the State of Illinois and is a ntribution from the Section of Wildlife Research of the Illinois Natural istory Survey. Dr. Frank C. Bellrose is a retired Wildlife Specialist and rincipal Scientist, Dr. Stephen P. Havera is Associate Wildlife Ecologist, nd Fred L. Paveglio, Jr., and Donald W. Steffeck are former Research ssistants in the Section of Wildlife Research.

Two or more outside referees recommend each manuscript submitted r publication in the Biological Notes series before it is accepted.

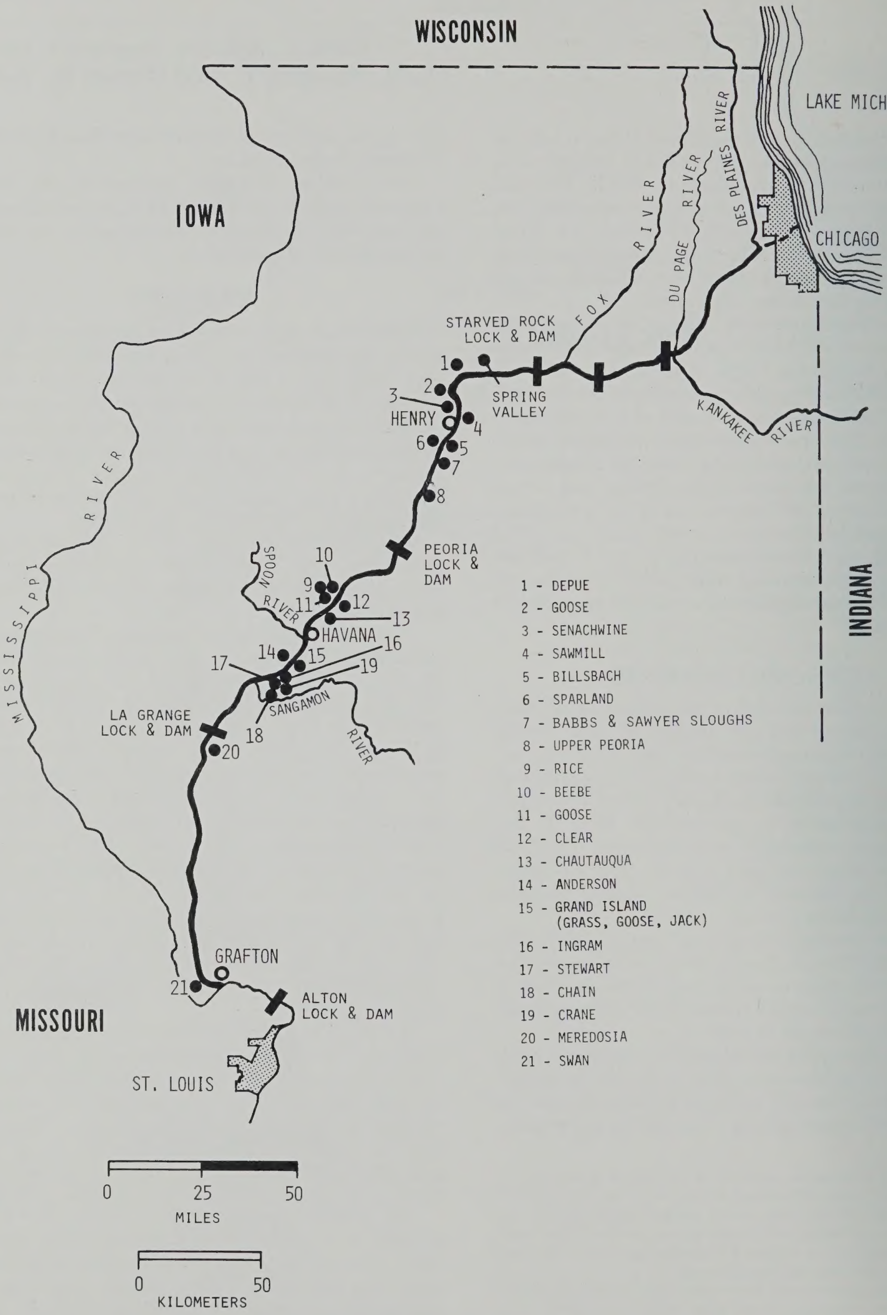


Fig. 2.—Bottomland lakes selected for volume analyses.

ool (Fig. 2). Lake depths were necessary for volume eterminations. Depending on the size and configuration of lake, between 5 and 12 transects were established across it. long each transect, depths were taken at intervals of pproximately 45–90 m (150–300 feet). To determine ottom elevations, depths recorded at each lake were related o the nearest river gauge reading adjusted for the slope of he river. These transects, with their associated depths, ere then transcribed onto photocopies of the 1974 Corps f Engineers aerial photos. The depths of Upper Peoria ake were taken from the 1976 Corps of Engineers map. ontour lines at 15-cm (6-inch) intervals were drawn onto e photocopies and the 1976 Upper Peoria Lake map. The rea within each contour interval was determined by using a mpensating polar planimeter. The volume of water in ach contour interval was calculated to the nearest acre-foot y multiplying the surface area by the mean depth of the ntour interval (Vanoni 1975:375–382). Acre-foot volumes ere then converted to cubic meters. The tree line was used s the boundary of these bottomland lakes, because the uctuation of water levels results in periodic variations in ke areas. Mean sea level (msl) elevations of the tree line ere determined by taking from 6 to 12 depth measure-ents at the tree line of each lake during high water and veraging these readings. The only exception was Upper eoria Lake, where normal pool elevation was used instead f the tree line. The Peoria Navigation Dam, located a short istance below Peoria Lake, maintains the lake at a fairly nstant level, not as evident in other bottomland water eas.

The percentage of surface area and of volume for each ntour interval were determined for the selected lakes, and ese percentages were totaled by navigation pool for eoria, La Grange, and Alton pools. The surface areas and lumes were then extrapolated for all bottomland water eas in these pools.

The lakes sampled for depth and volume comprised a tal of 17,209 hectares (42,523 surface acres), representing proximately 60 percent of the surface area of bottomland kes in the Illinois River valley. Therefore, we believe that e findings from our sample of lakes are representative of e surface area, volume, and depth of the lakes in the entire inois River valley from 1976 to 1979.

Discrepancies between the surface area of the bottom-nd lakes measured from the 1969 Recreational Develop-ent photos (Table 1) and the surface area derived from ld studies for volumetric work (Tables 7–11) resulted m difficulties in obtaining the depths of certain portions lakes because of access restrictions. For example, Goose ulton County), Ingram, Stewart, Chain, and Swan lakes all d portions of their basins that were separated from the incipal body of water by low levees; the area of the lakes Grand Island differs because a small lake separated from e Grass-Goose-Jack chain of lakes could not be reached by at (Fig. 2).

The average depth for the lakes sampled, the lakes in each of the three pools, and all the bottomland lakes was derived by dividing the volume by the surface area (i.e., cubic meters ÷ hectares = average depth).

Receding water levels expose mud flats between the tree line and the minimum pool. Maximum exposure of mud flats occurs at traditional low-water periods, primarily in July, August, and September, but the area of mud flats exposed varies with navigation pool levels. The percentage of occurrence of various water levels in the Illinois River for the 10 July–1 October growing period, the optimum time of mud flat exposure for moist-soil plant development, was calculated from U.S. Army Corps of Engineers river-stage data for Henry (Peoria Pool) and Havana (La Grange Pool) by determining the mean water level during the growing period for each of the 40 years from 1939 through 1978. The percentage of occurrence of these average water levels for each growing season was calculated for the 40-year period. We examined the relationship between the amount of surface area exposed for mud flats at 15-cm (6-inch) intervals and river levels for the lakes sampled in Peoria and La Grange pools (Fig. 2).

The amount of sedimentation and the sedimentation rate per year for the bottomland lakes were calculated from differences in water depths of the lakes from 1903 to 1979 or other intervals for which data were available.

Findings on certain bottomland lake surface areas, volumes, and water depths by Lee & Stall (1976, 1977) are slightly different from our data for several reasons. Because of fluctuating water levels, water surfaces are ill-defined; and where lakes interconnect, arbitrary delineations of the borders of individual lakes differ. We selected the tree line as the lake margin. Lee & Stall (1976, 1977) used the pool contour level, which was usually below the tree line in elevation. Their parameters reduced the surface areas and water depths of certain lakes in comparison with our data. Lee & Stall (1976, 1977) also included Goose Lake, Upper Peoria Lake, and Lower Peoria Lake in Peoria Lake. We excluded Goose Lake from Upper Peoria Lake and did not study the depth or sedimentation of Lower Peoria Lake. Lee & Stall (1977) selected transects of Upper Peoria Lake that were weighted toward the lower end, where the water was deeper. Moreover, they included the depth of the river channel in determining the depth of Peoria Lake; we excluded channel depths.

Lee & Stall partitioned each lake between transects and combined the averages of each partition for the lake as a whole. We used accumulative 0.5-foot (15-cm) contour intervals for the entire lake. These different techniques also made for slightly varying results.

Of the 15 lakes studied by Lee & Stall (1977:57), 6 were studied in detail and 9 were investigated in "reconnaissance" surveys involving reduced sampling. They studied 7 lakes (including Lower Peoria Lake) that we did not study, we studied 13 lakes that they did not study, and 8 lakes were included in both investigations. We provided Lee & Stall with the 1976 sedimentation data for Lake Chautauqua.

TABLE 1.—Surface areas of lakes existing in Peoria, La Grange, and Alton pools in 1903 and 1969.

Area	River Mile	1903 Surface Area		1969 Surface Area		Percent Chang
		Hectares	Acres	Hectares	Acres	
				Peoria Pool		
Ponds, Utica to Spring Valley	230–214	113	279	206	509	+82
Turner Lake	215	158	391	141	348	−11
Lyons Lake	213	7	17	18	43	+157
Depue Lake and Hicks Slough	211	153	378	266	658	+74
Spring Lake	210	77	190	238	589	+209
Coleman Lake	210	57	141	52	129	−9
Round Lake	209.5	2	5	6	15	+200
Lost Lake	209	3	7	3	6	0
Hickory Ridge Lake	208	13	32	24	59	+85
First Bridge Lake	207	10	25	6	15	−40
Goose Pond	204	472	1,166	823	2,034	+74
Senachwine Lake	201	1,070	2,644	1,654	4,086	+54
Siebolt Lake	200	149	368	177	438	+19
Sawmill Lake	197	229	566	282	698	+23
Mud Lake	196	24	59	26	65	+8
Town Lake	195	16	40	27	67	+69
Whitney Lake	195	5	12	7	16	+40
Merdian Slough	194	9	22	19	48	+111
Billsbach Lake	194	153	378	438	1,083	+186
Weis Lake	192	61	151	133	328	+118
Fisher's Slough	191	49	121	147	363	+200
Sparland (Goose) Lake	190	139	343	432	1,068	+211
Wightman Lake	188	79	195	258	638	+227
Sawyer Slough	188	21	52	200	494	+852
Babbs Slough	185	33	82	792	1,956	+2300
Big Meadow Lake	184	50	124	275	679	+450
Partridge Drainage and Levee District	181	54	133	913	2,255	+1591
Goose Lake	178	128	316	832	2,057	+550
Upper Peoria Lake	172	2,586	6,390	3,739	9,239	+45
Lower Peoria Lake	164	665	1,643	1,045	2,582	+57
Beesaw Lake	158	23	57	77	190	+235
Wesley Slough	160	11	27	31	76	+182
Subtotal		6,619	16,354	13,287	32,831	+101
				La Grange Pool		
Larish Lake	157	15	37	7	17	−53
Long and Mud lakes	156	32	79	191	472	+497
Pekin and Worley lakes	155	180	445	290	717	+61
Wood Duck Slough	149	1	2	3	8	+200
Boot Jack Lake	148	29	72	103	254	+255
Kingston Lake	147	21	52	31	76	+48
Ferry Lake	144	4	10	7	16	+75
Spring Lake	137	1,234	3,049	520	1,285	−58
Pond Lily Lake	136	27	67	28	69	+4
Rice-Miserable Lake	136	305	754	611	1,510	+100
Beebe (Big) Lake	136	267	660	553	1,366	+107
Lost Lake	135	19	47	16	39	−16
Goose Lake	134	7	17	333	823	+4657
Clear Lake	132	335	828	782	1,931	+133
Lake Chautauqua	128	237	586	1,523	3,763	+543
Liverpool Lake	128	118	292	75	185	−36
Quiver Lake	123	163	403	112	277	−31
Horseshoe Lake	121	12	30	10	23	−17
Matanzas Bay	116	128	316	194	479	+52
Dierker Lake	114	4	10	3	8	−25
Bath Lake	113	23	57	60	147	+161
Moscow Lake	109	54	133	108	267	+100
Grass Lake	111	46	114	233	575	+407
Goose Lake	110	74	183	117	289	+58
Jack Lake	108	238	588	362	894	+52
Anderson Lake	110	58	143	666	1,645	+1048
Patterson Bay	107	20	49	58	143	+190
Curtis Lake	107	17	42	7	17	−59
Powell Bay	106	18	44	25	63	+39
Mathews Bay	106	6	15	16	39	+167

TABLE 1.—Continued.

Area	River Mile	1903 Surface Area		1969 Surface Area		Percent Change
		Hectares	Acres	Hectares	Acres	
nicarte Lake	106	11	27	13	33	+18
amp Lake	106	7	17	12	29	+71
lim Lake	105	27	67	42	104	+56
ngram Lake	104	17	42	441	1,089	+2494
tewart Lake	103	511	1,263	567	1,400	+11
rane Lake	102	261	645	321	794	+23
hain Lake	100	32	79	226	559	+606
in Oak Lake	101	13	32	22	54	+69
ong Lake	100	16	40	60	149	+275
ickory Island Slough	100	28	69	29	72	+4
angamon Lake	99	11	27	62	152	+464
arkhausen (Cuba Island)	99	17	42	382	945	+2147
anganois area[a]	99	160	395	111	275	−31
angamon Bay	96	119	294	105	259	−12
ugar Creek Lake	95	40	99	75	184	+88
readway and Coleman's lakes	93	203	502	325	803	+60
ig Lake	93	67	166	45	111	−33
ittle Lake	93	17	42	18	45	+6
uscooten Bay area	90	361	892	498	1,231	+38
ork Lake	87	58	143	159	393	+174
outh Beardstown Lake	84	34	84	99	245	+191
ig Prairie area	81	71	175	266	658	+275
Subtotal		5,773	14,266	10,922	26,981	+89
			Alton Pool			
eredosia Lake	75	422	1,043	601	1,484	+42
onds, Meredosia Island	74	110	272	77	190	−30
arlow Lake	68	14	35	20	49	+43
mith-Atkinson area	67	99	245	120	297	+21
llens Lake area	63	17	42	78	192	+359
ck Ellis Lake	57	8	20	8	19	0
rairie Lake	56	7	17	9	22	+29
urricane Island Slough	27	9	22	5	12	−44
odars Swamp	26	37	91	55	136	+49
iamond Island Slough	24	10	25	51	127	+410
amilton Lake	23	3	7	5	12	+67
elmbold Slough	14	3	7	19	48	+533
he Glades	14	185	457	104	256	−44
owler Lake	12	24	59	97	240	+304
eep Lake	11	12	30	18	44	+50
ong Lake	11	31	77	28	68	−10
pper and Lower Flat lakes	10	21	52	65	160	+210
tump Lake	9	21	52	223	552	+962
wan and Fuller lakes	8	187	462	1,163	2,873	+522
ilbert Lake	5	39	96	94	232	+141
alhoun Point	3	83	205	351	868	+323
Subtotal		1,342	3,316	3,191	7,881	+137
Total:		*13,734*	*33,936*	*27,400*	*67,693*	*+100*

[a] Water areas in the Sanganois Conservation Area and its immediate vicinity are not delineated separately in this table

PRISTINE CONDITIONS

Early in the 1900's, the bottomland water areas of the llinois River were almost pristine even though a surprising mount of forest in the lower valley floodplain had been leared for cultivation. Water areas of numerous shapes and izes were scattered along both sides of the Illinois River rom Spring Valley to Grafton (Fig. 2). They took the forms f river marshes, long narrow sloughs, oval ponds or small akes, and lakes of large size that were often ameboid in hape. Those water areas fed by springs or streams aintained continuous outlets to the river, whereas others were separated from the river except during periods of overflow from floods. Although many bottomland water areas were in close proximity to the river, a number were separated from it by broad bands of forest up to 0.8 km (0.5 mile) in width.

In only one area, Chillicothe to Peoria (Peoria Lake), has the Illinois River maintained a channel through an extensive water area. An alluvial fan, created by the entrance of Ten Mile Creek, has pinched this once continuous broad expanse of water into two segments: Upper Peoria Lake and Lower Peoria Lake. Otherwise, all lakes are lateral along the remarkably narrow, straight river channel.

TABLE 2.—The numbers of water areas by size class (in hectares) in three regions of the Illinois Valley in 1903 and 1969 and the percentages leveed and unleveed. Changes in numbers and size class resulted first from diverted water from Lake Michigan and later from navigation dams.

Size Class (Hectares)	Peoria Pool								La Grange Pool								Alton Pool							
	Number				Percent				Number				Percent				Number				Percent			
	1903			1969	1903			1969	1903			1969	1903			1969	1903			1969	1903			1969
	Lev.[a]	Unl.[b]	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.
0.1–19.9	2	21	23	14	50.0	45.7	46.0	32.6	46	54	100	18	61.3	56.0	58.5	30.5	65	46	111	15	65.0	80.7	70.7	45.5
20.0–39.9	0	6	6	7		13.0	12.0	16.3	9	16	25	5	12.0	16.7	14.6	8.5	14	7	21	4	14.0	12.3	13.4	12.1
40.0–80.0	0	8	8	3		17.4	16.0	7.0	11	12	23	8	14.7	12.5	13.5	13.6	13	1	14	6	13.0	1.8	8.9	18.2
81.0–161.9	0	6	6	3		13.0	12.0	7.0	4	6	10	8	5.3	6.3	5.8	13.6	5	1	6	4	5.0	1.8	3.8	12.1
162.0–323.9	2	1	3	7	50.0	2.2	6.0	16.3	2	5	7	7	2.7	5.2	4.1	11.9	3	1	4	2	3.0	1.8	2.5	6.1
324.0–647.9	0	1	1	2		2.2	2.0	4.7	1	3	4	10	1.3	3.1	2.3	16.9	0	1	1	1	...	1.8	0.6	3.0
648.0–1,295.0	0	2	2	5		4.4	4.0	11.6	2	0	2	2	2.7	...	1.2	3.4	0	0	0	1	...	...	...	3.0
1,296.0–2,600.0	0	1	1	1		2.2	2.0	2.3	0	0	0	1	0.0	...	...	1.7	0	0	0	0	...	...	...	...
2,600 +	0	0	0	1		...	...	2.3	0	0	0	0	0.0	...	...	...	0	0	0	0	...	...	...	...
Total	*4*	*46*	*50*	*43*	*100.0*	*100.1*	*100.0*	*100.1*	*75*	*96*	*171*	*59*	*100.0*	*99.8*	*100.0*	*100.1*	*100*	*57*	*157*	*33*	*100.0*	*100.2*	*99.9*	*100.0*

[a] Lev. = Leveed.

[b] Unl. = Unleveed.

We glean a picture of the bottomlands with their lake sloughs, and marshes near the beginning of the 20 century from old maps, photographs, and a description l Kofoid (1903:151–155). The waters were much clearer the and were stained more from organic matter than from si Descriptions of the lake beds suggest that the bottoms soft black ooze resulted more from the decay of aquatic ar marsh vegetation than from the deposition of silt. Tl abundance of beds of pondweeds (*Potamogeton* spp coontail (*Ceratophyllum demersum*), and waterlilies (*Nyr phaea tuberosa*) in many of the lakes attests to wate sufficiently clear to provide these plants adequate light f photosynthesis (Fig. 3). Around the lake margins, emerge vegetation of two or more species of duck potato (*Sagittar latifolia, S. rigida*), marsh smartweed (*Polygonum co cineum*), river bulrush (*Scirpus fluviatillis*), and other le common species were found in extensive marshes. Kofo (1903:154) described the now drained Flag Lake as a "sea rushes." An old map of Senachwine Lake shows extensiv beds of wild rice (*Zizania aquatica*); indeed, two water are were named Rice Lake and Rice Pond, presumably becau of the abundance of this plant.

Although there were few large lakes in 1900, scores small lakes, ponds, and sloughs dotted the floodplain (Tab 2). Lakes of notable size were Goose (Bureau County Senachwine, Peoria, Beebe (Big), Spring (now large drained), Thompson and its neighbor Flag (both no drained), Crane, Stewart, and Meredosia. Numerous sma bodies of water, often linked by winding sloughs, we dispersed through the bottomland forest.

Even without additional water (diverted from Lak Michigan beginning in 1900) to add to the depths existing lakes, they were deeper than they are now. Som lakes in prediversion times had depths as great as 3.7–4.9 r (12–16 feet), but most were between 1.2 and 1.8 m (4– feet). Diverted water in the early 1900's added extensiv areas and about a meter to the depths of most water area

MAN'S INFLUENCE

Effects of Diverted Water

Water was diverted in appreciable volume from Lak Michigan to the Illinois River when the Sanitary and Shi Canal was opened at Chicago on 1 January 1900 (Fig. 4 However, limited amounts of lake water had entered th river after 1871 through the Illinois and Michigan Cana Diversion increased steadily until about 1920. Betwee 1900 and 1938, the average volume of Lake Michigan wate diverted into the Illinois River system was 205 cubic meter per second (m^3/s) (7,222 cubic feet per second [ft^3/s] Since 1939, the volume of diverted water has averaged 9 m^3/s (3,200 ft^3/s).

Diverted water increased low midsummer river level by as much as 2.1 m (7 feet) (Fig. 4) at Havana. Thi diversion resulted in a deepening and an extension of al water areas. Many water areas previously separated b stands of bottomland timber merged into larger bodies o water. Thousands of acres of trees, including numerous pi oak (*Quercus palustris*) and pecan (*Carya illinoensis*) stand

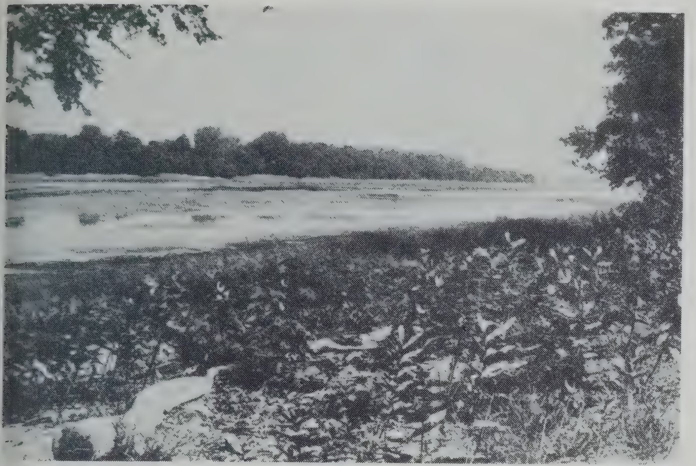


Fig. 3.—Quiver Lake in 1894 contained luxuriant beds of submerged aquatic plants, as is evident in this view. Resuspensions of bottom sediments eliminated aquatic plants from this lake after 1940.

at produced mast for a variety of wildlife, died from undation. As a consequence, current maps may label a ıgle water body with several names, reflecting the early 00's when the water areas were distinct entities.

Navigation dams completed in 1933 on the upper river ove Utica had a profound effect upon this reach, which s a narrow floodplain and a rapid fall (Bellrose et al. 77). The Peoria and La Grange dams, completed in 1938, d less effect on the middle portion of the river. The Alton ım, operational in 1938, appreciably raised water levels d enlarged the surface area of bottomland water bodies low Pearl. In the lower one-third of the pools, the dams ve maintained slightly higher minimum water levels ın those under maximum diversion rates. However, about midway up the pools, river levels become slightly lower than they were during peak diversion (Fig. 4).

The merging water bodies and their enlargement, first by diverted water and later by navigation dams, are reflected by the reduction in numbers of water bodies and a corresponding increase in total water area between 1903 and 1969 (Table 2). A comparison of the frequency of occurrence by size-class of water areas in the unleveed areas of the Illinois Valley in 1903 and in 1969 reveals the effect of increased river levels. The number of water areas in 1903 had declined 64 percent by 1969—from 378 bodies to 135 as they merged to enlarge the predominant water areas (Table 2). The enlargement of most existing water areas was considerable. The surface water area in the

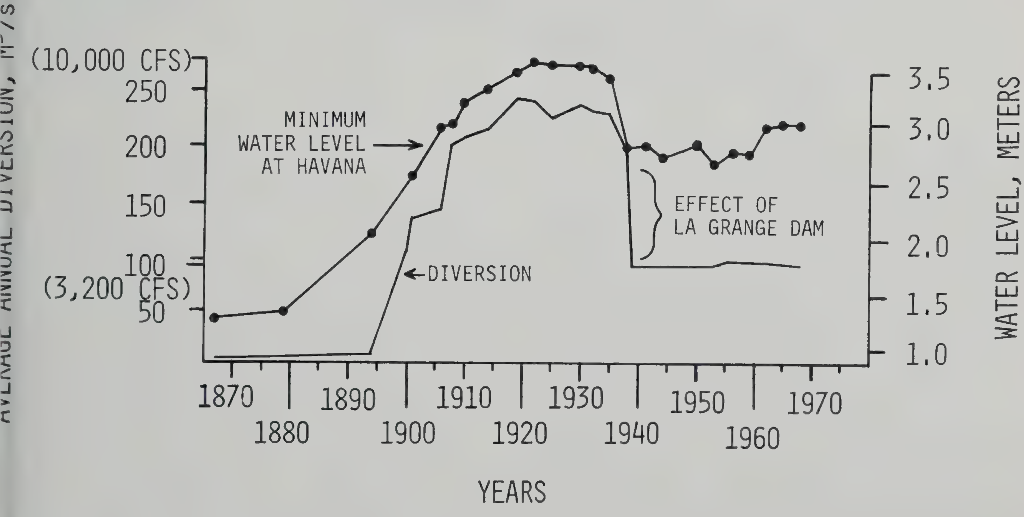


Fig. 4.—Average annual amounts of Lake Michigan water diverted into the Illinois River from 1865 to 1968 and corresponding river levels at Havana, nois (after Starrett 1972:147).

Illinois Valley approximately doubled as a result of the increase in river levels from diverted water, navigation dams, or both (Table 1).

Effects of Drainage and Levee Districts

During the early period of water diversion from Lake Michigan, drainage and levee districts were organized to convert large sections of the Illinois Valley into farmland. Although a few small districts in the higher floodplain were organized prior to 1900, those most strongly influencing the floodplain were formed between 1909 and 1922 (Mulvihill & Cornish 1929:38).

The sizes of drainage and levee districts and their water surfaces in 1903 prior to drainage are shown in Table 3. By the time these districts were formed, their water surfaces had approximately doubled because of the diverted water from Lake Michigan. Peoria Pool lost little of its water area to drainage with the formation of only two districts, one which was abandoned in 1926.

Because of diverted water, the water surface l through the drainage of lakes, sloughs, ponds, and marsh in the levee districts of La Grange Pool was almost twice t 5,508 ha (13,610 acres) present in 1903 (Table 3). T water bodies drained were, therefore, comparable in area the current 10,922 ha (26,981 acres) of backwater lak remaining in this region of the valley (Table 1).

Fig. 5 shows the effect of drainage and levees on t floodplain of the Illinois River above Havana. Seve drainage and levee districts were formed, 1910–1920, drain lakes on the west side of the river. However, on t east side of the river, levees of the defunct Chautauq District were used to create a larger body of water whe once numerous smaller lakes had occurred: Duck, Denn Grass, Goose, Libarger, and Widgeon.

TABLE 3.—Organized drainage and levee districts in the Illinois River valley extant in 1920 and their water surfaces in 1903 prior to drainage.

	Drainage and Levee Districts			1903	
Navigation Pool	Name	County	Ha[a]	Water Surface (Ha)	Percent Water
Peoria	Hennepin	Putnam	1,044	377	36.1
	Partridge	Woodford-Marshall	1,175	54	4.6
Subtotal			2,219	431	19.4
La Grange	Pekin and La Marsh	Peoria	1,066	24	2.3
	Rocky Ford	Tazewell	594	99	16.7
	Spring Lake	Tazewell	4,775	1,234	25.8
	Banner Special	Fulton-Peoria	1,848	258	14.0
	East Liverpool	Fulton	1,083	156	14.4
	Liverpool	Fulton	1,231	231	18.8
	Chautauqua	Mason	1,460	237	16.2
	Thompson Lake	Fulton	2,118	1,086	51.3
	West Matanzas and others	Fulton	4,282	186	4.3
	Big Lake	Schuyler	1,307	208	15.9
	Kelley Lake	Schuyler	399	21	5.3
	Lost Creek	Cass	1,109	2	0.1
	Coal Creek	Schuyler	2,588	95	3.7
	Crane Creek	Schuyler	2,030	102	5.0
	Big Prairie	Brown	731	71	9.7
	Valley	Cass	1,222	0	0.0
	South Beardstown	Cass	2,773	1,498	54.0
Subtotal			30,616	5,508	18.0
Alton	Meredosia Lake	Morgan-Cass	1,517	76	5.0
	Willow Creek	Morgan	1,738	38	2.2
	Little Creek	Brown	652	26	4.0
	McGee Creek	Pike-Brown	4,363	268	6.1
	Coon Run	Scott-Morgan	1,765	0	0.0
	Mauvais Terre	Scott	1,036	45	4.3
	Valley City	Pike	1,812	157	8.7
	Scott County	Scott	4,146	228	5.5
	Big Swan	Scott	5,159	396	7.7
	Hillview	Greene-Scott	4,987	801	16.1
	Hartwell	Greene	3,524	158	4.5
	Keach	Greene	3,194	328	10.3
	Eldred	Greene	3,415	87	2.5
	Spankey	Greene	324	16	4.9
	Nutwood	Greene-Jersey	4,297	229	5.3
Subtotal			41,929	2,853	6.8
Total			*74,764*	*8,792*	*11.8*

[a] Drainage and levee district hectares taken from Dickerson (1971).

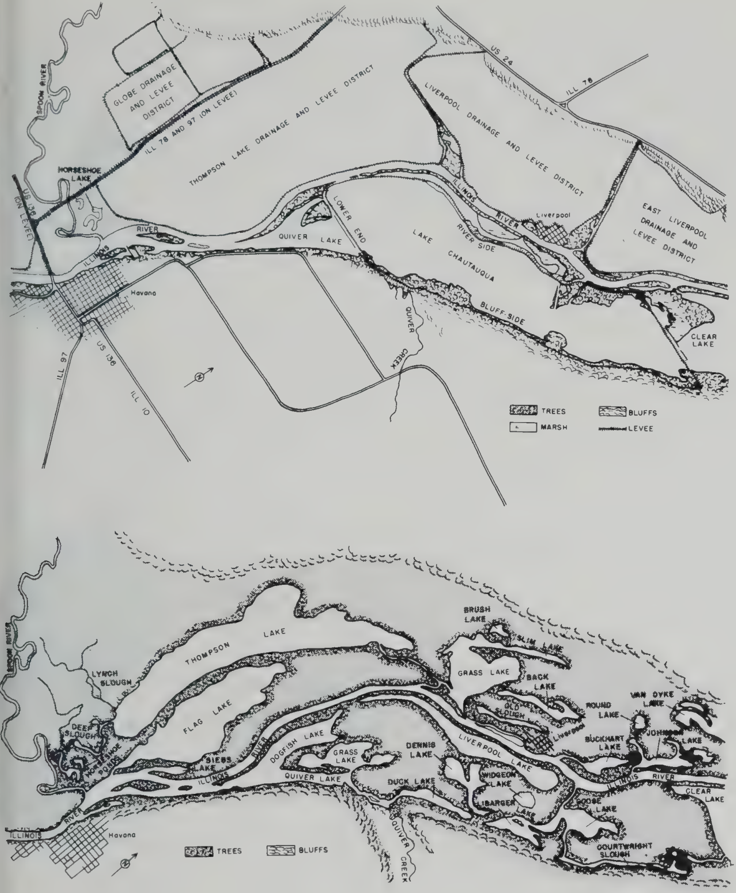


Fig. 5.—The Illinois River floodplain above Havana, Illinois, (top) as it appears now and (bottom) as it appeared before 1912. Note the elimination of natural lakes by drainage and levee districts (after Mills et al. 1966).

In the Alton Pool region of the Illinois Valley, about 853 ha (7,050 acres) of bottomland water areas existed in e levee districts prior to 1900 (Table 3). With diverted ater increasing the surface area 137 percent (Table 1), ere were 6,762 ha (16,709 acres) in the early 1900's. oday, there are 3,191 ha (7,881 acres) (Table 1). The area bottomland lakes in Alton Pool of the Illinois River was duced 53 percent by drainage and levee districts, representing a larger proportion of the floodplain than drainage stricts represent in other pools.

An overall appraisal of the changing water area of ttomlands in the Illinois Valley between Utica and afton indicates that under pristine conditions there were ,526 ha (55,662 acres) of ponds, sloughs, lakes, and arshes (Tables 1, 3). With the addition of diverted water, e surface area essentially doubled to a calculated 45,052 ha 11,323 acres), but in the next 20 years declined to about ,400 ha (67,693 acres), as drainage and levee districts croached upon the floodplain (Table 1).

Under pristine conditions, a few large and a multitude of small, dispersed water areas occurred in the lower 112 km (70 miles) of the valley as far up as Meredosia (Fig. 2). Above Meredosia, bottomland lakes were generally larger. As one proceeded upstream to La Salle, water areas occupied an increasing proportion of the 134,763-ha (333,000-acre) floodplain. The small dispersed water areas below Meredosia are probably attributable to the sedimentation resulting from the backing action of the Mississippi River on the Illinois River during flood times over the 12,000 years since the melt of the Wisconsin glaciation.

According to Mulvihill & Cornish (1929:37), in 1929 1 drainage and levee district occupied 4.9 percent of the 21,449-ha (53,000-acre) bottomland subject to overflow between La Salle and Peoria, 9 drainage and levee districts covered 72.5 percent of the 20,639-ha (51,000-acre) bottomland between Peoria and Havana, 9 districts embraced 30.5 percent of the 25,496-ha (63,000-acre) bottomland subject to overflow between Havana and Beardstown, and 19 districts contained 78.3 percent of the 67,179-ha (166,000-acre) floodplain between Beardstown and Grafton. Therefore, in 1929 a total of 38 drainage and levee districts occupied 56.4 percent (76,063 ha or 187,952 acres) of the total 134, 763 ha (333,000 acres) from La Salle to Grafton.

After all of the drainage and levee districts were established, changes occurred in the status of five districts (Table 4). The Partridge District, above Peoria, was abandoned in 1926. With subsequent reflooding, it has been acquired by several private duck clubs. The Rocky Ford Drainage and Levee District, near Pekin, was purchased by Commonwealth Edison Company and was converted into a cooling lake for its Powerton Station in 1971–1972.

Because of a court verdict, a remnant of Spring Lake was declared navigable, and therefore, was not drained. A 300-ha (741-acre) area was isolated by an internal levee from the remainder of the bottomland that was drained. In 1958, the Illinois Department of Conservation raised the water level 0.9 m (3 feet), increasing the size of Spring Lake to 520 ha (1,285 acres).

The Chautauqua Drainage and Levee District above Havana was flooded during the fall of 1926 and was subsequently abandoned. It has been a national wildl refuge since 1936. The levees that once excluded water n retain it to form a larger water area than occurred prior drainage (Table 4). The Big Prairie District discontinu levee maintenance in 1934, and water bodies there returned to their earlier sizes.

TABLE 4.—Water area before the creation and after the abandonment or partial reflooding of drainage and levee districts.

Navigation Pool	District	Water Surface in Hectares		
		Before Diversion	Before Drainage	
		1900	1902–1922	1969
Peoria	Partridge[a]	54	913	913
La Grange	Rocky Ford[b]	99	200	577[c]
	Spring Lake[d]	1,234	1,533	520
	Chautauqua[e]	237	540	1,523
	Big Prairie[f]	71	266	266

[a] Partridge district was reflooded in 1926.

[b] Rocky Ford district was converted to a power plant cooling lake, 1971–1972.

[c] This area differs slightly from the area in Table 3.

[d] The remnant of Spring Lake (Tazewell County) was increased by the Illinois Department of Conservation in 1958.

[e] Chautauqua district was flooded in 1926; its acquisition for a national wildlife refuge was started in 1936.

[f] Big Prairie district levees were abandoned in 1934; the district was later reflooded.

TABLE 5.—Change in the surface area (in hectares) of water in the Illinois River valley as a result of navigation pools created by dams.[a]

Navigation Pool	Main Channel Border, Lakes, Sloughs, Ponds		Marsh		Combined	
	Pre[b]	Post	Pre	Post	Pre	Post
Dresden Island	392	857	0	59	392	916
Marseilles	189	398	186	4	375	402
Starved Rock	174	834	0	0	174	834
Peoria	11,592	12,376	4,037	1,004	15,629	13,380
La Grange	8,967	10,378	3,125	1,082	12,092	11,460
Alton	3,157	4,490	1,055	927	4,212	5,417
Total	*24,471*	*29,333*	*8,403*	*3,076*	*32,874*	*32,409*

[a] Data for all navigation pools except Alton are from Bellrose et al. (1977:C-3, Table C-1). Data for Alton Navigation Pool in the lower Illinois River valley are from U.S. Army Corps of Engineers 1979.

[b] Preimpoundment prior to 1933. Postimpoundment after 1933 in the Dresden, Marseilles, and Starved Rock pools; after 1939 in Peoria, La Grange, and Alton pools.

By impinging on the floodplain of the Illinois River, t drainage and levee districts have "reduced the spa available for flow and for storage, which has the effect increasing flood stages" (Mulvihill & Cornish 1929:3 Walraven (1950:39) has pointed out that with nea identical stream flows of 3,257 m^3/s (115,000 ft^3/s) Beardstown in 1904 and 1943, the river was 3 m (9.7 fe higher in 1943. He attributed the reduction in the floodpla by levees as the cause for the increase in river level with t same rate of discharge.

During the 1943 flood, several levees broke, resulting the inundation of over 22,000 ha (54,400 acres) of botto land. As a consequence, the flood crest was apprecial lowered, and Walraven (1950:39) concluded that levees h "raised the high water mark at Beardstown by more th ten feet." He calculated (1950:40) that to lower the flo crest 0.3 m (1 foot) would require a reduction in flow of m^3/s (3,400 ft^3/s) at Kingston Mines, 188 m^3/s (6,6 ft^3/s) at Beardstown, and 227 m^3/s (8,000 ft^3/s) Meredosia.

To reduce flood heights when critical river stages we reached, Walraven (1950:70–74) proposed using certa drainage and levee districts for storage of flood waters. other times shallow lakes would be maintained within t districts for fish, wildlife, and outdoor recreation.

Effects of Navigation Dams

The creation of a 2.7-m (9-foot) waterway, resulti largely from dams constructed in the Illinois River by t

TABLE 6.—Surface areas of bottomland lakes between Chicago Starved Rock Lock and Dam (upper pools).

Bottomland Lake	River Mile	Hectares	Ac
Dresden Island Pool			
Jackson Creek Lake	278	3	
Lake	277	12	
Kankakee River Lake	273	8	
Dresden Island Dam Impoundment	272	196	4
Total		219	5
Marseilles Pool			
Aux Sable Lake	270	31	
Negro Slough	268	4	
Peacock Slough	265	5	
Moody Bayou	254	4	
McNellis Bayou	252	12	
Total		56	1
Starved Rock Pool			
Lake	233	46	1
Starved Rock Dam Impoundment	233	875	2,1
Total		921	2,2
Grand total for upper pools		*1,196*	*2,9*

TABLE 7.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depths of selected bottomland lakes in Peoria Pool (above Peoria Lake), 1978.

Water Depth[a]			Depue Lake				Goose Lake (Putnam County)				Senachwine Lake			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
441.5	Tree line													
441.0	0.15	0.5	38	94	29,592	24	180	444	136,863	111	171	423	130,698	106
440.5	0.30	1.0	35	87	80,145	65	186	459	424,152	344	85	210	194,814	158
440.0	0.46	1.5	33	81	125,766	102	242	597	919,818	746	123	305	469,773	381
439.5	0.61	2.0	26	64	138,096	112	214	529	1,142,991	927	156	386	832,275	675
439.0	0.76	2.5	27	66	181,251	147	1	3	7,398	6	256	632	1,754,559	1,423
438.5	0.91	3.0	32	78	263,862	214	1	2	4,932	4	658	1,627	5,516,442	4,474
438.0	1.07	3.5	16	40	161,523	131	...	...	...	...	174	430	1,724,967	1,399
437.5	1.22	4.0	21	52	242,901	197	...	...	...	...	30	73	339,075	275
437.0	1.37	4.5	14	35	186,183	151	...	...	...	...	...	...	...	...
436.5	1.52	5.0	11	28	161,523	131	...	...	...	...	...	...	...	...
436.0	1.68	5.5	10	25	160,290	130	...	...	...	...	...	...	...	...
435.5	1.83	6.0	3	8	54,252	44	...	...	...	...	...	...	...	...
Total			*266*	*658*	*1,785,384*	*1,448*	*824*	*2,034*	*2,636,154*	*2,138*	*1,653*	*4,086*	*10,962,603*	*8,891*
Average depth[b]			0.67 m, 2.2 feet				0.32 m, 1.1 feet				0.66 m, 2.2 feet			

TABLE 7.—Continued.

Water Depth[a]			Sawmill Lake				Billsbach Lake				Sparland Lake			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
441.5	Tree line													
441.0	0.15	0.5	70	172	53,019	43	66	164	50,553	41	106	262	80,762	66
440.5	0.30	1.0	23	57	53,019	43	47	116	107,271	87	45	111	102,709	83
440.0	0.46	1.5	44	108	166,455	135	48	119	183,717	149	68	167	257,820	209
439.5	0.61	2.0	42	103	220,707	179	96	238	512,928	416	138	342	738,814	599
439.0	0.76	2.5	51	125	345,240	280	92	228	632,529	513	38	93	257,697	209
438.5	0.91	3.0	9	22	76,446	62	42	103	350,172	284	31	76	258,683	210
438.0	1.07	3.5	2	5	19,728	16	15	36	143,028	116	6	16	63,376	51
437.5	1.22	4.0	7	17	80,145	65	14	35	162,756	132	...	...	...	...
437.0	1.37	4.5	18	45	236,736	192	9	23	122,067	99	...	...	...	...
436.5	1.52	5.0	8	20	117,135	95	7	17	98,640	80	...	...	...	...
436.0	1.68	5.5	10	24	155,358	126	2	4	23,427	19	...	...	...	...
435.5	1.83	6.0	...	...	...	...	...	...	...	...	...	...	...	...
Total			*284*	*698*	*1,523,988*	*1,236*	*438*	*1,083*	*2,387,088*	*1,936*	*432*	*1,067*	*1,759,861*	*1,427*
Average depth[b]			0.54 m, 1.8 feet				0.55 m, 1.8 feet				0.41 m, 1.3 ft			

TABLE 7.—Continued.

Water Depth[a]			Babbs Slough & Sawyer Slough				Total				Percent of Total	
			Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
441.5	Tree line											
441.0	0.15	0.5	236	583	180,018	146	867	2,143	661,505	537	17.7	2.6
440.5	0.30	1.0	97	240	221,940	180	518	1,280	1,184,050	960	10.6	4.6
440.0	0.46	1.5	127	313	483,336	392	684	1,691	2,606,685	2,114	14.0	10.2
439.5	0.61	2.0	241	596	1,286,019	1,043	913	2,257	4,871,830	3,951	18.7	19.1
439.0	0.76	2.5	167	412	1,141,758	926	630	1,557	4,320,432	3,504	12.9	17.0
438.5	0.91	3.0	85	211	716,373	581	858	2,120	7,186,910	5,829	17.6	28.2
438.0	1.07	3.5	19	46	184,950	150	232	573	2,297,572	1,863	4.8	9.0
437.5	1.22	4.0	16	40	183,717	149	88	218	1,008,594	818	1.8	4.0
437.0	1.37	4.5	4	9	48,087	39	46	113	593,073	481	0.9	2.3
436.5	1.52	5.0	...	...	...	...	26	64	377,298	306	0.5	1.5
436.0	1.68	5.5	...	...	...	...	21	52	339,075	275	0.4	1.3
435.5	1.83	6.0	...	...	...	...	3	8	54,252	44	0.1	0.2
Total			*993*	*2,450*	*4,446,198*	*3,606*	*4,886*	*12,076*	*25,501,276*	*20,682*	*100.0*	*100.0*
Average depth[b]			0.45 m, 1.5 feet				0.52 m, 1.7 feet					

[a] Gauge readings in mean sea level at Henry, Illinois

[b] Volume ÷ surface area

TABLE 8.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below normal pool elevation and average depth of Upper Peoria Lake in 1976.

Water Depth[a]			Upper Peoria Lake				Percent of Total	
			Surface Area		Volume		Surface Area	Volume
msl	m	ft	ha	a	m³	a-ft		
440.0	Normal pool elevation							
439.5	0.15	0.5	78	192	59,184	48	1.8	0.2
439.0	0.30	1.0	96	238	219,474	178	2.3	0.6
438.5	0.46	1.5	139	343	528,957	429	3.2	1.3
438.0	0.61	2.0	187	463	999,963	811	4.4	2.5
437.5	0.76	2.5	693	1,714	4,753,215	3,855	16.2	12.1
437.0	0.91	3.0	597	1,474	4,998,582	4,054	14.0	12.7
436.5	1.07	3.5	855	2,113	8,467,011	6,867	20.0	21.5
436.0	1.22	4.0	546	1,350	6,240,213	5,061	12.8	15.8
435.5	1.37	4.5	392	969	5,077,494	4,118	9.2	12.9
435.0	1.52	5.0	147	364	2,133,090	1,730	3.5	5.4
434.0	1.83	6.0	193	477	3,234,159	2,623	4.5	8.2
433.0	2.13	7.0	54	133	1,064,079	863	1.3	2.7
432.0	2.44	8.0	32	79	727,470	590	0.7	1.9
431.0	2.74	9.0	34	85	887,760	720	0.8	2.3
Channel[b]	2.74+	9.0+	232	574	...	...	5.4	...
Total			*4,044*	*9,994*	*39,390,651*	*31,947*	*100.1*	*100.1*
Total + channel			4,275	10,568				
Average depth[c]			0.98 m, 3.2 feet					

[a] Gauge reading in mean sea level at Peoria, Illinois

[b] Channel not included in total volume.

[c] Volume ÷ surface area.

TABLE 9.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depths of selected bottomland lakes in La Grange Pool, 1976–1978.

Water Depth[a]			Rice Lake				Beebe Lake				Goose Lake (Fulton County)			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
434.4	Tree line													
433.9	0.15	0.5	85	209	64,116	52	98	243	75,213	61	47	116	35,757	29
433.4	0.30	1.0	21	52	48,087	39	68	168	155,358	126	18	44	40,689	33
432.9	0.46	1.5	28	69	106,038	86	119	294	452,511	367	28	68	103,572	84
432.4	0.61	2.0	36	88	191,115	155	149	367	790,353	641	55	136	292,221	237
431.9	0.76	2.5	50	124	342,774	278	111	274	759,528	616	49	120	331,677	269
431.4	0.91	3.0	143	353	1,197,243	971	7	17	56,718	46	...	...	...	...
430.9	1.07	3.5	193	478	1,916,082	1,554	1	3	13,563	11	...	...	...	...
430.4	1.22	4.0	56	138	638,694	518	1	1	3,699	3	...	...	...	...
429.9	1.37	4.5	...	...	...	...	...	...	...	...	...	...	...	...
Total			*612*	*1,511*	*4,502,149*	*3,653*	*554*	*1,367*	*2,306,943*	*1,871*	*197*	*484*	*803,916*	*652*
Average depth[b]			0.74 m, 2.4 feet				0.42 m, 1.4 feet				0.41 m, 1.3 feet			

TABLE 9.—Continued.

Water Depth[a]			Clear Lake				Lake Chautauqua				Anderson Lake			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
434.4	Tree line													
433.9	0.15	0.5	103	254	77,679	63	203	502	155,358	126	78	193	59,184	48
433.4	0.30	1.0	53	130	120,834	98	200	493	456,210	370	43	107	98,640	80
432.9	0.46	1.5	62	154	237,969	193	212	525	810,081	657	40	99	152,892	124
432.4	0.61	2.0	98	243	524,025	425	504	1,246	2,689,173	2,181	57	141	304,551	247
431.9	0.76	2.5	100	248	686,781	557	339	837	2,322,972	1,884	86	213	590,607	479
431.4	0.91	3.0	169	417	1,413,018	1,146	64	159	537,588	436	100	247	835,974	678
430.9	1.07	3.5	141	349	1,399,455	1,135	...	...	...	...	123	303	1,215,738	986
430.4	1.22	4.0	55	137	632,529	513	...	...	...	...	136	335	1,549,881	1,257
429.9	1.37	4.5	...	...	...	...	...	...	...	...	3	7	34,524	28
Total			*781*	*1,932*	*5,092,290*	*4,130*	*1,522*	*3,762*	*6,971,382*	*5,654*	*666*	*1,645*	*4,841,991*	*3,927*
Average depth[b]			0.65 m, 2.1 feet				0.46 m, 1.5 feet				0.73 m, 2.4 feet			

TABLE 9.—Continued.

Water Depth[a]			Chain Lake				Crane Lake				Grand Island			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
434.4	Tree line													
433.9	0.15	0.5	24	60	18,495	15	34	84	25,893	21	139	343	106,038	86
433.4	0.30	1.0	20	49	45,621	37	41	102	93,708	76	59	147	135,630	110
432.9	0.46	1.5	16	39	60,417	49	59	146	225,639	183	50	123	189,882	154
432.4	0.61	2.0	61	150	323,046	262	87	215	463,608	376	210	520	1,122,030	910
431.9	0.76	2.5	62	154	426,618	346	38	94	260,163	211	166	409	1,135,593	921
431.4	0.91	3.0	43	107	363,735	295	28	69	233,037	189	24	59	200,979	163
430.9	1.07	3.5	...	...	...	...	26	63	253,998	206	38	93	372,366	302
430.4	1.22	4.0	...	...	...	...	8	19	88,776	72	9	22	99,873	81
429.9	1.37	4.5	...	...	...	...	1	2	11,097	9	...	...	...	...
Total			*226*	*559*	*1,237,932*	*1,004*	*322*	*794*	*1,655,919*	*1,343*	*695*	*1,716*	*3,362,391*	*2,727*
Average depth[b]			0.55 m, 1.8 feet				0.51 m, 1.7 feet				0.48 m, 1.6 feet			

TABLE 9.—Continued.

Water Depth[a]			Ingram & Stewart Lakes				Total				Percent of Total	
			Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
434.4	Tree line											
433.9	0.15	0.5	143	355	109,737	89	955	2,360	727,470	590	14.8	2.1
433.4	0.30	1.0	138	341	315,648	256	660	1,632	1,510,425	1,225	10.3	4.4
432.9	0.46	1.5	168	416	641,160	520	782	1,932	2,980,161	2,417	12.1	8.6
432.4	0.61	2.0	141	348	750,897	609	1,398	3,454	7,451,019	6,043	21.7	21.5
431.9	0.76	2.5	205	506	1,403,154	1,138	1,205	2,978	8,259,867	6,699	18.7	23.8
431.4	0.91	3.0	78	193	653,490	530	655	1,619	5,491,782	4,454	10.2	15.9
430.9	1.07	3.5	...	...	...	...	522	1,290	5,171,202	4,194	8.1	14.9
430.4	1.22	4.0	...	...	...	...	264	652	3,013,452	2,444	4.1	8.7
429.9	1.37	4.5	...	...	...	...	4	9	45,621	37	0.1	0.1
Total			*873*	*2,159*	*3,874,086*	*3,142*	*6,445*	*15,926*	*34,650,999*	*28,103*	*100.1*	*100.0*
Average depth[b]			0.44 m, 1.5 feet				0.54 m, 1.8 feet					

[a] Gauge reading in mean sea level at Havana, Illinois

[b] Volume ÷ surface area

TABLE 10.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depth of Meredosia and Swan and Flat lakes in Alton Pool, 1978.

Water Depth		Meredosia Lake				Swan and Flat Lakes				Total				Percent of Total	
		Surface Area		Volume		Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
0.0	Tree line														
0.15	0.5	82	202	61,650	50	89	221	67,815	55	171	422	129,465	105	10.7	1.3
0.30	1.0	66	163	150,426	122	83	206	191,115	155	149	369	341,541	277	9.3	3.5
0.46	1.5	74	183	282,357	229	82	202	311,949	253	156	385	594,306	482	9.7	6.1
0.61	2.0	64	159	342,774	278	163	403	870,498	706	227	562	1,213,272	984	14.2	12.4
0.76	2.5	68	167	462,375	375	265	655	1,817,442	1,474	333	822	2,279,817	1,849	20.8	23.3
0.91	3.0	106	261	879,129	713	236	582	1,974,033	1,601	341	843	2,853,162	2,314	21.3	29.2
1.07	3.5	58	144	575,811	467	75	185	741,033	601	133	328	1,316,844	1,068	8.3	13.4
1.22	4.0	69	171	790,353	641	7	18	85,077	69	76	189	875,430	710	4.8	8.9
1.37	4.5	7	17	91,242	74	...	...	...	...	7	17	91,242	74	0.4	0.9
1.52	5.0	6	14	81,378	66	...	...	...	...	6	14	81,378	66	0.4	0.8
1.68	5.5	2	4	25,893	21	...	...	...	...	2	4	25,893	21	0.1	0.3
Total		*602*	*1,485*	*3,743,388*	*3,036*	*1,000*	*2,472*	*6,058,962*	*4,914*	*1,601*	*3,955*	*9,802,350*	*7,950*	*100.0*	*100.1*
Average depth[a]		0.62 m, 2.0 feet				0.61 m, 2.0 feet				0.61 m, 2.0 feet					

[a] Volume ÷ surface area

TABLE 11.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depth of bottomland lakes in the entir Illinois River valley, Utica to Grafton, Illinois, 1976–1978.

		Peoria Pool, Excluding Peoria Lake				Peoria Lake (Upper & Lower)				La Grange Pool			
Water Depth		Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
0.0	Tree line												
0.15	0.5	1,363	3,367	1,038,186	842	102	253	77,679	63	1,618	3,998	1,233,000	1,00
0.30	1.0	814	2,012	1,860,597	1,509	126	312	288,522	234	1,119	2,765	2,557,242	2,07
0.46	1.5	1,075	2,657	4,094,793	3,321	182	450	692,946	562	1,325	3,273	5,044,203	4,09
0.61	2.0	1,435	3,547	7,653,231	6,207	246	609	1,314,378	1,066	2,368	5,852	12,627,153	10,24
0.76	2.5	991	2,448	6,791,364	5,508	911	2,251	6,243,912	5,064	2,042	5,045	13,997,016	11,35
0.91	3.0	1,348	3,332	11,299,212	9,164	783	1,936	6,564,492	5,324	1,110	2,744	9,304,218	7,54
1.07	3.5	365	901	3,612,690	2,930	1,123	2,775	11,121,660	9,020	884	2,185	8,757,999	7,10
1.22	4.0	139	344	1,588,104	1,288	717	1,772	8,193,285	6,645	447	1,104	5,102,154	4,13
1.37	4.5	72	177	924,750	750	515	1,273	6,668,064	5,408	6	14	70,281	5
1.52	5.0	40	101	589,374	478	194	479	2,803,842	2,274	...	...	...	...
1.68	5.5	33	82	527,724	428	253	626	4,245,218	3,443	...	...	...	...
1.83	6.0	4	11	81,378	66	...	...	...	...	...	...	...	...
2.13	6.5	...	...	...	...	71	175	1,401,921	1,137	...	...	...	...
2.44	7.0	...	...	...	...	...	...	...	...	...	...	...	...
2.74	7.5	...	...	...	...	42	103	949,410	770	...	...	...	...
2.74 + channel	8.0	...	...	...	...	...	...	...	...	...	...	...	...
	8.5	...	...	...	...	45	111	1,163,952	944	...	...	...	...
	9.0	...	...	...	...	...	...	...	...	...	...	...	...
	9.0 + channel	...	...	...	...	305	754	...	...	...	...	...	...
Total		*7,680*	*18,979*	*40,061,403*	*32,491*	*5,615*	*13,879*	*51,729,282*	*41,954*	*10,919*	*26,980*	*58,693,266*	*47,60*
Average depth[a]		0.52 m, 1.7 feet				0.97 m, 3.2 feet				0.55 m, 1.8 feet			

TABLE 11.—Continued.

		Alton Pool (La Grange to Grafton)				Total				Percent of Total	
Water Depth		Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
0.0	Tree line										
0.15	0.5	340	841	258,930	210	3,423	8,458	2,607,795	2,115	12.5	1.5
0.30	1.0	298	736	680,616	552	2,357	5,825	5,386,977	4,369	8.6	3.2
0.46	1.5	310	767	1,182,447	959	2,892	7,146	11,014,389	8,933	10.6	6.5
0.61	2.0	453	1,119	2,414,214	1,958	4,503	11,127	24,008,976	19,472	16.4	14.1
0.76	2.5	662	1,637	4,541,139	3,683	4,606	11,381	31,573,431	25,607	16.8	18.6
0.91	3.0	680	1,680	5,695,227	4,619	3,922	9,692	32,863,149	26,653	14.3	19.3
1.07	3.5	265	654	2,621,358	2,126	2,637	6,516	26,113,707	21,179	9.6	15.4
1.22	4.0	153	378	1,745,928	1,416	1,456	3,597	16,629,471	13,487	5.3	9.8
1.37	4.5	14	35	182,484	148	606	1,497	7,845,579	6,363	2.2	4.6
1.52	5.0	11	28	161,523	131	246	607	3,554,739	2,883	0.9	2.1
1.68	5.5	3	8	51,786	42	294	727	4,906,107	3,979	1.1	2.9
1.83	6.0	...	...	...	...	...	...	...	...	...	...
2.13	6.5	...	...	...	...	71	175	1,401,921	1,137	0.3	0.8
2.44	7.0	...	...	...	...	...	...	...	...	...	...
2.74	7.5	...	...	...	...	42	103	949,410	770	0.2	0.6
2.74 + channel	8.0	...	...	...	...	...	...	...	...	...	...
	8.5	...	...	...	...	45	111	1,163,952	944	0.2	0.7
	9.0	...	...	...	...	...	...	...	...	...	...
	9.0 + channel	...	...	...	...	305	754	...	...	1.1	...
Total		*3,189*	*7,883*	*19,535,652*	*15,844*	*27,405*	*67,716*	*170,019,603*	*137,891*	*100.1*	*100.1*
Average depth[a]		0.61 m, 2.0 feet				0.62 m, 2.0 feet					

[a] Volume ÷ depth, excluding channel

U.S. Army Corps of Engineers, had a moderate effect on water areas in the valley. From the confluence of the Des Plaines and Kankakee rivers, which form the Illinois, six dams separate the river into long, narrow navigation pools: Dresden Island, Marseilles, Starved Rock, Peoria, La Grange, and Alton. The locks and dams at Starved Rock and abov were completed in 1933, those at Peoria and La Grange i 1939, and that at Alton in 1938. Each navigation pool i maintained at a minimum depth of 2.7 m (9 feet), bu depths increase during periods of flooding.

The navigation pools in the Illinois River proper are termed "flat pools" by engineers because of the slight water-surface slope from the upper end to the dam under low-flow conditions. With high-flow levels, the upper end of a pool may be as much as 1.5 m (5 feet) higher than the lower end. The dams enable an increasing water flow to be spilled until the upper end of one pool becomes as high as the lower end of the one immediately above. At normal river stages, water velocity is less than 1.6 km (1 mile) per hour. The low rate of flow compounds the problem of sedimentation.

The change wrought by the dams on the surface area of water in the Illinois Valley was nominal (Table 5). One reason that the increase was not more drastic was the curtailment in diverted water that occurred at that time. The most noticeable change occurred immediately above the Dresden Island and Starved Rock locks and dams, where the main channel was greatly broadened to the benefit of fish and waterfowl (Havera et al. 1980).

Increases in the open water of bottomland lakes because of the impounding of Peoria and La Grange pools occurred largely at the expense of marshes that succumbed to deeper water (Table 5). Overall there was a decrease of wetlands in these two pools, because sedimentation allowed the invasion of black willows into more aquatic habitats (Bellrose et al. 1977).

Impoundment by the Alton Navigation Dam on the Mississippi River appreciably enlarged bottomland water areas on the lower Illinois River (Table 5). Most of this increase occurred in the lower 32 km (20 miles) of the river valley between Hardin and Grafton.

FIELD DETERMINATIONS

Surface Area

The surface areas of the few bottomland lakes existing in the upper navigation pools were measured by planimeter from the 1974 aerial photos (Table 6). The surface area and water volume within each 0.15-m (0.5-foot) contour interval and the average depths of selected lakes are presented by pools in Tables 7 through 11.

About 28,601 ha (70,672 acres) of bottomland lakes occurred in the Illinois River valley, 1976–1979 (Tables 6 and 11). Of the designated pools in the Illinois River valley, the upper navigation pools (Dresden Island, Marseilles, and Starved Rock) had the smallest number of bottomland lakes (11) and smallest water surface area (1,196 ha or 2,956 acres) (Table 6). The few bottomland areas in the upper pools are a result of the narrow river valley in this portion of the waterway and a greater rate of fall in the river above than below Starved Rock. Peoria Pool had the largest area in bottomland lakes (13,295 ha or 32,858 acres) mainly because of Peoria Lake, a large lake in the main stem (Table 11). The water surface area of bottomland lakes in La Grange Pool totaled 10,919 ha (26,980 acres) (Table 11). Alton Pool had 3,189 ha (7,883 acres) of surface water in its bottomland lakes (Table 11). Peoria and La Grange pools combined contained 85 percent of the total surface area and 102 of the 146 (70 percent) bottomland lakes in the Illinois Valley.

Volume of Water

In Peoria Pool, about 74 percent of the estimated 40 million m^3 (32,000 acre-feet) of water volume in the bottomland lakes (excluding Peoria Lake) occurred between 0.46 and 0.91 m (1.5 and 3.0 feet) below the tree line water level (Table 11). Peoria Lake, however, contained 75 percent of its 51.7 m^3 (42,000 acre-feet) of estimated water volume between 0.76 and 1.37 m (2.5 and 4.5 feet) below pool level. Peoria Lake contained almost three-quarters as much surface area as all the other lakes in Peoria Pool and exceeded their combined volume by approximately 11.6 million m^3 (9,500 acre-feet), denoting its greater depth. La Grange Pool had about the same surface acreage and volume in bottomland lakes as Peoria and Alton pools combined, with the exclusion of Peoria Lake (Table 11). In La Grange Pool, 76 percent of its calculated 58.7 million m^3 (47,600 acre-feet) of water volume occurred between 0.61 and 1.07 m (2.0 and 3.5 feet), about 0.3 m (1 foot) deeper than the comparable bottomland water areas in Peoria Pool (Table 11). Alton Pool had the smallest surface area and water volume in bottomland lakes compared with those of Peoria and La Grange pools. It is similar in depth to La Grange Pool, with 78 percent of its estimated 19.5 million m^3 (15,840 acre-feet) of volume occurring between 0.61 and 1.07 m (2.0 and 3.5 feet) below the tree line. For the Illinois River valley from Utica to Grafton, we calculated an estimated total volume of 170 million m^3 (137,900 acre-feet) when the water is at the tree line, with about 77 percent of the volume occurring between 0.61 and 1.22 m (2.0 and 4.0 feet) below the tree line (Table 11).

Depth

Perhaps the most striking and discouraging finding from our investigations is that in 1976–1979 the average depth of bottomland lakes in the Illinois Valley was only 0.62 m (2.0 feet) (Table 11). Because of the filling in of lakes as a result of the severe sedimentation in the valley, the lakes in Peoria Pool (except Peoria Lake) averaged only 0.52 m (1.7 feet) in depth (Table 11). Peoria Lake averaged 0.97 m (3.2 feet), the lakes in La Grange Pool averaged 0.55 m (1.8 feet), and Alton Pool lakes averaged 0.61 m (2.0 feet) (Table 11).

Although most of the bottomland lakes closely resemble one another, there are some differences. The shallowest lake that we sampled (Goose Lake, Peoria Pool; 0.32 m, 1.1 feet; Table 7) has a tributary stream that flows into it, further aggravating the serious sedimentation problem arising from the main stem of the river. Historically, Peoria Lake has been deeper than all other bottomland lakes, and the channel flows through it. We believe that before the building of the Peoria Lock and Dam in 1939, the channel current transported more of the sediment load through the lake than it has since that time. Apparently because of the reduced current resulting from the dam, a greater proportion of the channel sediment load is now being deposited in Peoria Lake. In La Grange Pool, two of the deepest lakes are Rice and Anderson with an average depth of about 0.74 m (2.4 feet) (Table 9). Rice Lake has remained relatively deep as a result of its distance from the river and of low levees that have reduced the ingress of river water. Low levees have also protected Anderson Lake from inundation by small and moderate floods.

Mud Flats

The areas of mud flats of selected lakes in Peoria and La Grange pools at 0.15-m (0.5-foot) contour intervals and the mud-flat area extrapolated for all lake basins in these pools are presented in Tables 12 and 13. We also calculated the percentage of time for each year between 1939 and 1978 that water levels occurred at each mean sea level stage in the period 10 July–1 October. Exposed mud flats during this period are necessary for the establishment of moist-soil plants (Fig. 6), currently the primary source of naturally occurring foods for waterfowl. If mud flats are exposed and moist-soil plants become established for at least 70 days and are not overtopped by water during this critical period, plants mature and produce seed, which is then available to waterfowl. However, moist-soil plants are generally killed by complete inundation before maturation. For optimum development of moist-soil food resources, 90 days are desirable. Fewer than 70 days results either in seeds not maturing or in a low volume of seed production.

The area of mud flats exposed varies from year to year as summer water levels change. In Peoria Pool, about 2,406 ha (5,945 acres) of mud flats are potentially available (Table 12). This maximum area of mud flats occurred with low-water conditions that prevailed about 47.5 percent of the time during the 1939–1978 period (Table 12). In

TABLE 12.—The number of hectares (acres) of mud flats potentially available in selected lakes of Peoria Pool in relation to mean sea level river stages at Henry for the entire moist-soil-plant growing season, 10 July–1 October, 1939–1978.

Lake	MSL at Henry in Feet				
	442.1+	441.5	441.0	440.5	Total
Depue Lake	Above tree line	Tree line	38 (94)	35 (86)	73 (180)
Goose Lake			180 (444)	186 (459)	366 (903)
Senachwine Lake			171 (423)	85 (210)	256 (633)
Sawmill Lake			70 (172)	23 (57)	93 (229)
Billsbach Lake			66 (164)	47 (116)	113 (280)
Sparland Lake			106 (262)	45 (111)	151 (373)
Babbs Slough			236 (583)	97 (240)	333 (823)
Total area			*867* *(2,142)*	*518* *(1,279)*	*1,385* *(3,421)*
Extrapolated area for Peoria Pool[a]			1,465 (3,620)	941 (2,325)	2,406 (5,945)
Percent of yearly occurrence[b]	12.5	15.0	25.0	47.5	

[a] Selected lake conditions extrapolated for the entire pool area on the basis of seasonal stages by years (Table 11).

[b] Percentage of years from 1939 to 1978 that water levels for the period 10 July–1 October averaged this height.

TABLE 13.—The number of hectares (acres) of mud flats potentially available in selected lakes of La Grange Pool in relation to mean sea level river stages at Havana for the entire moist-soil-plant growing season, 10 July–1 October, 1939–1978.

msl Havana (feet)	Rice Lake	Beebe Lake	Goose Lake	Clear Lake	Lake Chautauqua	Anderson Lake	Grand Island	Ingram-Stewart Lakes	Chain Lake	Crane Lake	Total Area	Extrapolated Area La Grange Pool[a]	Percent of Yearly Occurrence[b]
434.9+	Above tree line												5.0
434.4	Tree line												2.5
433.9	85 (209)	98 (243)	47 (116)	103 (254)	203 (502)	78 (193)	139 (343)	144 (355)	24 (60)	34 (84)	955 (2,360)	1,618 (3,998)	0.0
433.4	21 (52)	68 (168)	18 (44)	53 (130)	200 (493)	43 (107)	59 (147)	138 (341)	20 (49)	41 (102)	661 (1,632)	1,119 (2,765)	7.5
432.9	28 (69)	119 (294)	28 (68)	62 (154)	212 (525)	40 (99)	50 (123)	168 (416)	16 (39)	59 (146)	782 (1,932)	1,324 (3,273)	10.0
432.4	36 (88)	149 (367)	55 (136)	98 (243)	504 (1,246)	57 (141)	210 (520)	141 (348)	61 (150)	87 (215)	1,398 (3,454)	2,368 (5,852)	7.5
431.9	50 (124)	111 (274)	49 (120)	100 (248)	339 (837)	86 (213)	166 (409)	205 (506)	62 (154)	88 (94)	1,205 (2,978)	2,042 (5,045)	15.0
431.4	143 (353)	7 (17)	. . .	169 (417)	64 (159)	100 (247)	24 (59)	78 (193)	43 (107)	28 (69)	655 (1,619)	1,110 (2,744)	15.0
430.9	193 (478)	1 (3)	. . .	141 (349)	. . .	123 (303)	38 (93)	. . .	. . .	26 (63)	522 (1,290)	884 (2,185)	17.5
430.4	56 (138)	. . .	. . .	55 (137)	. . .	136 (335)	9 (21)	. . .	. . .	8 (19)	264 (652)	447 (1,104)	20.0
Total	*612* *(1,511)*	*553* *(1,366)*	*197* *(484)*	*781* *(1,932)*	*1,522* *(3,762)*	*663* *(1,638)*	*695* *(1,715)*	*874* *(2,159)*	*226* *(559)*	*321* *(792)*	*6,442* *(15,917)*	*10,912* *(26,966)*	*100.0*

[a] Selected lake conditions extrapolated for the entire pool area on the basis of seasonal stage by years (Table 11).

[b] Percentage of years between 1939 and 1978 that water levels for the period 10 July–1 October averaged this height.

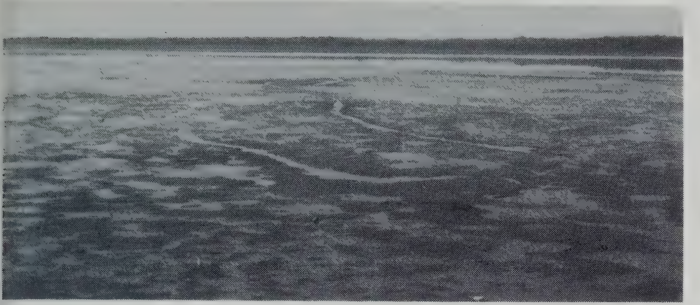


Fig. 6.—Lake Chautauqua from the southeast shore in August 1979. Extensive mud flats have been exposed by receding water levels in the shallow, platter-shaped basin.

comparison, La Grange Pool has potentially 10,912 ha (26,966 acres) of mud flats, about four and a half times as much as Peoria Pool (Table 13). However, the maximum area of mud flats occurred in La Grange Pool only about 20 percent of the time during the growing seasons of 1939 through 1978. Water levels vary less in Peoria Pool than they do in La Grange Pool, because the Peoria dam is 0.3 m (1 foot) higher than the La Grange dam, the slope of the river is less acute in Peoria Pool, and large tributary streams add more sizeable discharges to the river in La Grange Pool.

SEDIMENTATION

Lee & Stall (1976:27) made a theoretical calculation of the annual sediment loss in the Illinois River Basin of 25 million metric tons (t) (27.6 million tons) or 3.34 t/ha (1.49 tons/acre). They calculated that 62 percent of the silt came from valley slopes of tributary rivers and the parent valley, and 38 percent from upland areas. About 11 million t (12.1 million tons) of sediment are annually transported out of the Illinois Valley to the Mississippi River at Grafton, leaving 14 million t (15.4 million tons) deposited in the water areas and certain unleveed areas of the floodplain. Lee & Bhowmik (1979:18, Fig. 6) show the rate of sediment transport in relation to the volume of water in the Illinois River. They found little transport of sediment with low discharge and increases in sediment load with increasing water volume until a saturation threshold is reached.

An analysis by Lee & Stall (1977:51–52) of the deposited sediments revealed that they were made up almost equally of silt and clay particles and insignificant amounts of sand. Lee & Stall suggested that sediments originated on upland watersheds and were transported to the Illinois River by tributary streams. A dry volume weight of 1,179 t (1,300 tons) of sediment would cover 0.4 ha (1 acre) to a depth of 30.5 cm (1 foot). The dry volume weight was determined by weighing the wet samples, oven drying the samples, reweighing them, and applying the data to a standard equation (Lee & Stall 1977:49). Thus, 14 million t (15.4 million tons) of sediment deposited annually in the Illinois Valley would cover 57,529 ha (142,154 acres) to a depth of 2.5 cm (1 inch).

About 58,276 ha (144,000 acres) of unleveed bottomland between La Salle and Grafton are subject to flooding (Mulvihill & Cornish 1929:37). To this would be added the 27,400 ha (67,693 acres) of lake surface (Table 1) and approximately 8,903 ha (22,000 acres) of river surface, aggregating 94,579 ha (233,700 acres).

Thus, under a maximum overflow of the river's natural banks, 94,579 ha (233,700 acres) would be subject to the deposit of 14.6 million m^3 (11,845 acre-feet) of sediment (Lee & Stall 1976:27), yielding an average of 0.63 cm/ha (0.61 inch/acre). Seldom does a flood cover this extensive

TABLE 14.—The total sediment and yearly amount of sediment in certain bottomland lakes of the Illinois River valley.

Navigation Pool	Lake	Time Interval	Average Annual Sediment Deposit in Centimeters	Average Total Sediment in Centimeters
Peoria	Senachwine	1903–1978	1.27	94.9
	Sawmill	1903–1978	1.11	83.4
	Billsbach	1903–1978	1.12	83.8
	Sparland	1903–1978	1.07	79.9
	Babbs Slough	1903–1978	0.71	52.9
	Upper Peoria	1903–1965[a]	1.67[b]	103.8
		1965–1976[a]	3.06	33.7
		1903–1976	1.88	137.5
La Grange	Clear	1903–1978	1.56	117.3
	Beebe	1903–1978	0.75	56.4
	Rice	1903–1977	0.26	19.1
	Chautauqua	1926–1950	1.05[b]	25.1
		1950–1976	1.06	27.4
		1926–1976	1.05	52.5
	Matanzas	1903–1979	1.62	122.8
	Anderson	1903–1977	0.41	30.5
	Grand Island[c]	1903–1978	0.95	71.0
Alton	Meredosia	1903–1956[d]	1.30[b]	68.9
		1956–1978[d]	1.19	26.2
		1903–1978	1.27	95.1
	Swan	1903–1978	0.85	64.1
Overall average			*1.06*	
Weighted average based on area of lake basins			1.24	

[a] U.S. Army Corps of Engineers 1965, 1976.

[b] Where three time periods are shown, only the longest period was used to calculate the overall average and the weighted average.

[c] Grass, Goose, and Jack lakes.

[d] Illinois Division of Waterways 1956

an area. However, as the river rises, an increasing load of sediments enters the lateral lakes. There are 26,300 ha (89,700 acres) of water surface in the river and bottomland lakes. If they received the entire sediment load that Lee & Stall (1976:27) calculated is deposited annually in the Illinois Valley, it would fill the beds of these areas at the rate of 1.63 cm/ha per year (1.58 inches/acre per year). Because part of the sediment is deposited on adjacent floodplain lands, the calculated deposition of sediments in the waters of the Illinois Valley would be between 0.63 cm/ha and 1.63 cm/ha per year. Using the sedimentation rates for a cross section of lakes, 1903–1979 (Table 14), we calculated a weighted mean of 1.24 cm/ha per year. Because sedimentation rates have been higher in the recent years of that period, the 1.24 cm of sediments deposited yearly appears conservative and approximates the estimates by Lee & Stall (1976:27) derived from an entirely different basis employing the universal soil loss equation (Upper Mississippi River Comprehensive Basin Study Coordinating Committee 1970).

The sedimentation of bottomland lakes in the Illinois Valley has been studied by the Illinois State Water Survey (Lee & Stall 1976, 1977; Lee & Bhowmik 1979) and the Illinois Natural History Survey (Bellrose et al. 1979). The studies by the Water Survey have centered on the diminution of the storage capacity of bottomland lakes as a result of sedimentation. Those by the Illinois Natural History Survey have been concerned with yearly sedimentation rates in relation to water depth.

It is important to make a distinction between the terms "sedimentation rate" and "amount of sedimentation." Sedimentation rate is the thickness of sediments that have been deposited at a given water depth during 1 year. The amount of sedimentation or fill refers to the quantity of sediments deposited over an entire lake basin or at a specific location during an elapsed time of 1 or more years. The sedimentation rate provides a means of comparing the amount of sedimentation at similar water depths between years and between lakes.

These terms are important because Bellrose et al. (1979:30–32) found that as the water depth increased, the sedimentation rate increased. Sedimentation in a body of water, therefore, becomes a dynamic factor—subject to change as water depths change. It has resulted in the basins of the bottomland lakes changing from a diversity of depths to uniformly shallow, platter-shaped collections of ooze.

Linear regression trend lines are used to compare sedimentation rates with water depths for a number of lakes in each of the lower three navigation pools (Fig. 7, 8). The y-intercept for the trend lines is negative for 6 of the 10 lakes. Apparently, at the interface between water and land, ice and wave action have eroded bottom soils, thus actually deepening the lake basins slightly in shoal areas. In some cases, entire islets and low peninsulas have been washed away, most evident at Senachwine and Chautauqua lakes. However, elsewhere the basins have become very shallow from the deposition of sediments. Some of the sediments deposited in deeper water were originally displaced by ice and waves, but this movement of material within a lake is minuscule compared with the volume of sediments brought in by the river.

In our endeavor to determine the basin capacities of the

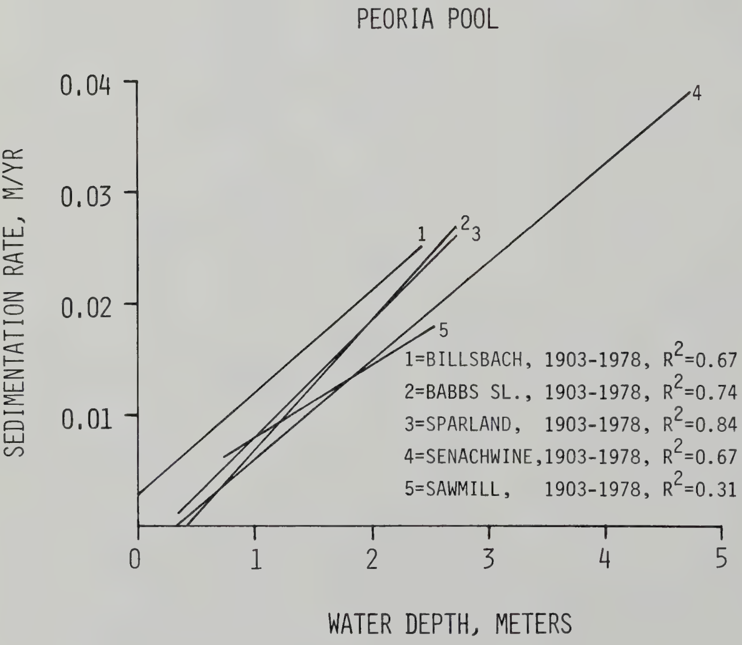


Fig. 7.—Linear relationships between the depth of water and the yearly rate of sedimentation in five bottomland lakes in Peoria Pool. All relationships are significant ($P < 0.01$).

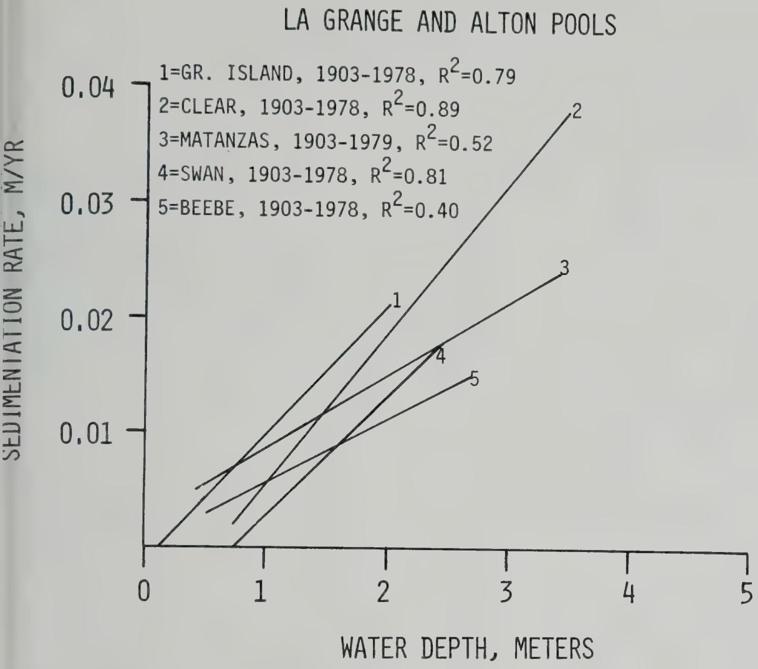


Fig. 8.—Linear relationships between the depth of water and the yearly rate of sedimentation in five bottomland lakes in La Grange and Alton pools. All relationships are significant ($P < 0.01$).

ottomland lakes in the Illinois Valley, some of the lakes urveyed in 1976 for deposited sediments (Bellrose et al. 979:30) were resurveyed in 1978. More transects were nade in each lake in the 1978 surveys, and all transects xtended from wooded shoreline to wooded shoreline. ecause of low-water conditions on certain lakes, transects n the 1976 survey did not always extend as far as the horeline. At that time, we did not recognize that this ailure would create a slightly erroneous extrapolation of he relationship between water depth and sedimentation ate, because shoreline areas have the lowest sedimentation ates (because of reduced water depths) and may in some nstances actually be deepened by ice and waves.

Therefore, we have included in this paper linear egression trend lines comparing sedimentation rates with vater depths for lakes that were surveyed in 1978–1979 Fig. 7, 8), including some of those surveyed in 1976 and reviously reported (Bellrose et al. 1979:30, Fig. 9). The rincipal difference between the results obtained by the 976 survey and the 1978 survey occurred in the lakes of eoria Pool, the 1978 survey resulting in slightly lower egression slopes and in greater negative y-intercepts for a umber of lakes (Fig. 7; Bellrose et al. 1979:30, Fig. 9).

Sedimentation rates are high for Babbs Slough (Fig. 7) nd for Grand Island lakes and Clear Lake (Fig. 8); they are ow for Beebe, Matanzas, and Sawmill lakes (Fig. 7, 8).

The rates of sedimentation shown for lakes of the llinois Valley are alarming, particularly because of the xisting shallow waters. Moreover, if more recent time eriods than 1903–1978 are considered, the sedimentation rates are appreciably higher and, therefore, more critical (Fig. 9; Bellrose et al. 1979:32, Fig. 11, 12, 13).

A number of lake basins were partially or entirely surveyed for bottom elevations between 1903 and our 1978 survey. In 1936 the Peoria Office, U.S. Army Corps of Engineers, surveyed the river-side half of five lakes: Senachwine, Sawmill, Billsbach, Sparland, and Babbs Slough. We used our bottom elevations from 1978 for the same transect sections to make comparisons on the change of sedimentation rates between 1903–1936 and 1936–1978 (Fig. 9). It is apparent that during the later period, 1936–1978, the sedimentation rates for all five lakes combined were higher, particularly in the shallower waters, than they were in the earlier period, 1903–1936 (Fig. 9).

A recalculation of the amount of sedimentation for several lakes surveyed in 1976 and reported in Bellrose et al. (1979:34) and data for some additional lakes are presented in Table 14. A comparison of current data with the yearly amount of sedimentation given by Bellrose et al. (1979:34) provides these differences between 1976 and 1978 surveys: Senachwine, Sawmill, Billsbach, and Sparland had slightly lower amounts of sediment deposits, whereas Babbs Slough, Upper Peoria Lake, and Chautauqua had slightly higher amounts. We found higher amounts of sedimentation in more recent years for Lake Chautauqua, Meredosia Lake, and especially Upper Peoria Lake. For example, data from the 1965–1976 period show that Upper Peoria Lake now averages about 1 m (3.2 feet) in depth and is being filled in over its entire basin at an average amount of 3.1 cm/year (1.2 inches/year) (Table 14).

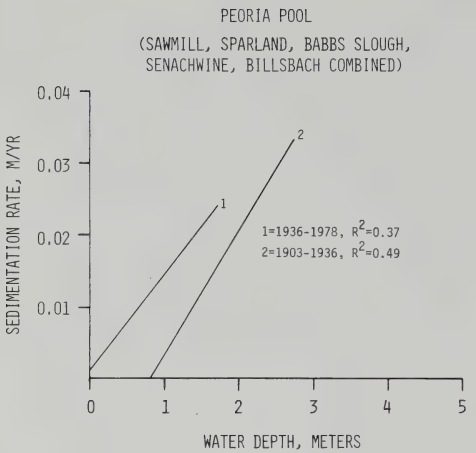


Fig. 9.—Linear relationships between the depth of water and the yearly rate of sedimentation for half of Senachwine and of Sawmill, Billsbach, and Sparland lakes and Babbs Slough combined for two time periods. The relationships are significant ($P < 0.01$).

OUTLOOK FOR THE FUTURE

Because of our concern with the extreme sedimentation problem occurring in the Illinois River valley, we have projected our current knowledge of sedimentation rates and average depths of the bottomland lakes into the 21st century. Ideally, we wish to achieve some plausible index to the longevity, both biological and recreational, of the bottomland water areas. We have attempted to estimate how much longer the Illinois River bottomland lakes will afford recreational opportunities for limited fishing, duck hunting, and boating.

Information from the linear regressions of sedimentation rates versus depths for individual lakes (Fig. 7, 8; Bellrose et al. 1979:30–32) and the 1976–1979 depths of each lake (Tables 7–10) were used in a modified half-life equation typically employed for chemical reactions. Because sedimentation is dynamic, with the rate under constant modification as waters become shallower, we believed that a mathematical relationship using the slope of the linear regression of sedimentation rates versus depths would be appropriate. We also realized that it may be more accurate to estimate when the bottomland lakes would be filled to half their current depth rather than when they would be completely filled, because sedimentation rates are reduced and subject to other influences in extremely shallow water. In addition, when the lakes are filled to half of their current depth, they will have little biological or recreational value.

Dr. Saul Blumenthal, Department of Mathematics, University of Illinois, used the following rationale to develop an equation for estimating the number of years required for a given bottomland lake to fill to half of its average 1976–1979 depth. The linear regressions of sedimentation rate versus depth (Fig. 7, 8) can be expressed as

$$\frac{dS(t)}{dt} = kY(t) + b$$

Where

$\frac{dS(t)}{dt}$ = sedimentation rate

$S(t)$ = thickness of sediment accumulated at time t

$Y(t)$ = depth of water at time t

k = slope of sedimentation regression line

b = y-intercept of sedimentation regression line

However, the depth of water $Y(t)$ is decreasing as t sediment depth increases. Therefore,

$$\frac{dY(t)}{dt} = \frac{-dS(t)}{dt}$$

and equation (1) becomes

$$\frac{dY(t)}{dt} = -kY(t) - b$$

The general solution to differential equation (2) is

$$Y(t) = Ae^{-kt} - \frac{b}{k}$$

Where

A = an arbitrary constant

If we set the current time to zero ($t = 0$) in equation (3), v can relate A to the water depth (Y_0) at the present tin Equation (3) then becomes

$$Y_0 = A - \frac{b}{k} \quad \text{or} \quad A = Y_0 + \frac{b}{k}$$

Equation (3) can then be rewritten as

$$Y(t) = (Y_0 + \frac{b}{k})e^{-kt} - \frac{b}{k}$$

We can now solve equation (4) for the time t required for given bottomland lake to fill to half its average 1976–19 depth (Y_1):

$$t = \frac{1}{k} \ln \frac{Y_0 + \frac{b}{k}}{Y_1 + \frac{b}{k}}$$

Where

t = number of years

k = slope of sedimentation regression line

b = y-intercept of sedimentation regression line

Y_0 = 1976–1979 average depth

Y_1 = half of 1976–1979 average depth

The results of equation (5) in predicting the number c years in which selected lakes will lose half of their averag

Table 15.—Projected number of years required for selected bottomland lakes to be filled to half of their average 1976–1979 depth. Predictions were generated from a "half-life" equation using values from linear regressions (both actual and forced through the origin) of sedimentation rates vs. depth.

Lake	Dates for Sedimentation Rate	1976–1979 Depth in Meters	Actual Regression Equation		Regression Forced Through Origin	
			R^2	Years	R^2	Years
		Peoria Pool				
Senachwine	1903–1978	0.66	. . .	. . .	0.65[a]	91
Sawmill	1903–1978	0.54	0.31[a]	74	0.31[a]	97
Sparland	1903–1978	0.41	0.84[a]	. . .	0.81[a]	81
Babbs Slough	1903–1978	0.45	0.74[a]	. . .	0.64[a]	87
Billsbach	1903–1978	0.55	0.67[a]	44	0.63[a]	63
Upper Peoria	1903–1965	0.98	0.63[a]	232	0.62[a]	90
	1965–1976	0.98	0.74[a]	63	0.67[a]	24
	1903–1976	0.98	0.83[a]	182	0.81[a]	82
		La Grange Pool				
Beebe	1903–1978	0.42	0.40[a]	128	0.40[a]	127
Rice	1903–1977	0.74	0.50[a]	. . .	0.33[a]	230
Clear	1903–1978	0.65	0.89[a]	. . .	0.82[a]	72
Chautauqua	1926–1950	0.46	0.41[a]	. . .	0.35[a]	76
	1950–1976	0.46	0.51[a]	. . .	0.41[a]	60
	1926–1976	0.46	0.70[a]	. . .	0.59[a]	76
Matanzas	1903–1979	0.95	0.52[a]	71	0.51[a]	95
Anderson	1903–1977	0.73	0.57[a]	. . .	0.42[a]	154
Grand Island lakes[b]	1903–1978	0.48	0.79[a]	110	0.69[a]	72
		Alton Pool				
Meredosia	1903–1956	0.62	0.89[a]	. . .	0.69[a]	115
	1956–1978	0.62	0.27[a]	. . .	0.17[a]	93
	1903–1978	0.62	0.84[a]	. . .	0.66[a]	119
Swan	1903–1978	0.61	0.81[a]	. . .	0.63[a]	119

[a] $P < 0.01$

[b] Grass, Goose, and Jack lakes.

976–1979 depth are presented in Table 15. The number of ears range between 44 for Billsbach and 74 for Sawmill in eoria Pool (excluding Peoria Lake) and between 71 for latanzas and 128 for Beebe in La Grange Pool.

It was not possible to generate a "half-life" value on the asis of the existing linear regressions for several of the elected lakes (Table 15). This difficulty occurred when the -intercept of the sedimentation regression had a moderate r large negative value. When this value is substituted into he "half-life" equation (5), a natural log of a negative umber must be taken, thus prohibiting further calculation.

To remedy these negative y-intercepts and allow use of he "half-life" prediction equation (5), the regressions etween sedimentation rates versus depth were rerun for he selected lakes, but the regression line was forced hrough the origin. We believe that it is hydrologically valid) use this statistical approach. Theoretically, there should e a minimum of sedimentation at the lake margin, and the egression line should go through the origin. However, as reviously explained, the effects of wave action on the horeline, where minimum depths occur, cause erosion of he shore and shallow areas with the resultant translocation f this soil elsewhere in the lake. Thus, in most cases, ninimum or negative sedimentation occurred in shallow epths adjacent to the shoreline (Fig. 7, 8, 9).

Once again, the selected lakes in Peoria Pool had shorter half-lives" than those in La Grange Pool (Table 15). The umber of years predicted for the chosen lakes in Peoria ool to fill to half of their average 1976–1979 depth ranged from a catastrophic 24 years in Upper Peoria Lake to 97 years for Sawmill. The time estimated to fill in half of the average depth for those lakes studied in La Grange Pool varied from 60 years for Lake Chautauqua to 230 years for Rice Lake.

It should be noted that the predictions for Upper Peoria Lake, Chautauqua, and Meredosia, when based on sedimentation rates from recent years (1965–1976, 1950–1976, and 1956–1978, respectively), are shorter than when sedimentation rates covering a longer span of years (1903–1976, 1926–1976, and 1903–1978, respectively) are used (Table 15). As discussed previously, the sedimentation rates are much higher in recent years, thus contributing to the shorter predicted "half-lives." If current land-use practices and accompanying excessive soil losses continue, then our "half-life" calculations are overly conservative.

DISCUSSION

For a brief period in the history of the Illinois River valley, man improved it for fish and waterfowl. This improvement occurred in the early 1900's, as water diverted from Lake Michigan doubled the surface area of the bottomland lakes. Although bottomland forests and their attendant wildlife suffered diminution as thousands of hectares of trees succumbed to inundation, the enhancement for fish and waterfowl was economically much greater.

The commercial catch of fish in the Illinois River rose steadily from 1894 and reached a peak in 1908 (U.S.

Department of Commerce and Labor 1911). At that time the Illinois River provided 10 percent of all freshwater fish caught in the United States. Thereafter, the commercial fish yield of the Illinois River steadily declined (Mills et al. 1966:15).

Following the brief improvement in the first decade of this century, man's activities have been largely destructive to fish and waterfowl as well as other wildlife resources of the Illinois Valley. First, the levees constructed along the river, mostly between 1909 and 1922 (Mulvihill & Cornish 1929:38), resulted in the loss of 17,584 ha (43,450 acres) of water surface, 39 percent of the total (Tables 2, 3). This loss is calculated on the basis of diverted waters doubling the 8,792 ha of lakes present in 1903 before the development of drainage and levee districts. Such a reduction in water area resulted in a comparable decrease in the fish production and waterfowl food resources of the valley.

Urban pollution began to be a problem in the upper river by 1911 (Mills et al. 1966:8–9) and ballooned in scope during World War I. Between 1915 and 1920, the zone of pollution moved downstream from the Chicago area at the rate of 26 km (16 miles) per year (Mills et al. 1966:9); by 1923 the river was almost devoid of free oxygen as far south as Chillicothe (Greenfield 1925:24–25). Pollution abatement in the last two decades has improved the dissolved oxygen levels of the river but not necessarily those of the adjacent bottomland lakes (Sparks & Starrett 1975:345–346). The reduction in oxygen content in the bottomland lakes is attributed to the resuspension of fine silts from the shallow lake bottoms by wave action. The resuspended material exerts an oxygen demand, removing dissolved oxygen from the water (Butts 1974:12).

Fish life has not increased to the degree anticipated from the improvement of dissolved oxygen in the river (Mills et al. 1966; Sparks & Starrett 1975:345). A principal factor appears to be the sediments deposited in the bottomland lakes (Bellrose et al. 1977:IV-a). These lakes play an important role in the fishery of the Illinois Valley. Their potential fish yield in relation to the river is exemplified by Richardson's (1921:464) findings that in 1908 "the largest poundages of fish per acre have been taken in the reaches with the largest quotas of connecting lake-acreage." Richardson (1921:464) pointed out that the fish yield in the lakes was probably greater because of the greater abundance of weed fauna and bottom fauna.

Water turbidity, resulting from sedimentation, has increased in the river and bottomland lakes (Bellrose et al. 1977:C-42). Turbidity reduces the food supply of panfish and game fish and their reproduction (Sparks & Starrett 1975:339). Most aquatic plant beds have been eliminated, and marsh plants have been drastically reduced in the bottomland lakes as a result of turbidity (Bellrose et al. 1979:28–29). Aquatic plants not only benefit fish, but are an important food resource to several species of dabbling and diving ducks.

In addition to the harmful indirect effects of sediments on the fish and wildlife resources of the Illinois River valley, they produce direct effects on the lake basins. Our surveys on the volume of water in Illinois Valley lakes at a normal water stage (the tree line) show that they are extreme shallow (Tables 7–11). Originally they were deeper, ar man made them still deeper by either diverted water fro Lake Michigan or the construction of navigation dam However, since 1903 all evidence indicates that sediment tion is increasingly reducing their depths.

We found that between 1903 and 1976–1979, the larg lakes in the Illinois Valley had filled with sediments annual average amounts varying from 0.26 to 1.88 c (0.10–0.74 inch), and the average for all lakes was 1.06 c (0.42 inch) (Table 14). Lee & Stall (1976:55) reported th between 1903 and 1975 Sawmill Lake had filled at a year amount of 1.19 cm (0.47 inch), Swan Lake (Calhou County) at 0.46 cm (0.18 inch), and Meredosia Lake at a amount of 1.09 cm (0.43 inch). Our calculations of year amounts of sedimentation were slightly different: Sawmil 1.11 cm (0.44 inch); Swan, 0.85 cm (0.33 inch); an Meredosia, 1.27 cm (0.50 inch) (Table 14).

Studies at several lakes point to higher sedimentatio rates in more recent years (Fig. 9). The importance presenting annual sedimentation rates for two differen time periods is that they provide a means of evaluatin differences in the sediment load transported by the Illino River. Fig. 9 compares yearly sedimentation rates for tw time periods: 1903–1936 and 1936–1978. The yearly rat was higher in the 1936–1978 period for the five lake combined. Higher sedimentation rates were also found fo the more recent of two time periods for Upper Peoria Lak Lake Chautauqua, and Meredosia Lake (Bellrose et a 1979:32; Steffeck et al. 1980).

All of our evidence points to a dramatic increase in th sediment load of the Illinois River during recent years. Thi increase is not only reflected in higher sedimentation rate but also in the total amount of sediment, as evidenced i both Upper Peoria Lake and Lake Chautauqua (Table 14 The current status of Lake Chautauqua, exemplifying th condition of many other floodplain lakes, is portrayed i Fig. 6.

The "half-life" equation (5) provides a means of usin the history of sedimentation to predict its effect upon th lakes of the Illinois Valley in the future. Half of the meage volume of these lakes will be lost in a relatively few decade (Table 15). Although much of the sport and commercia fishery value has already been lost as a result of sedimentation, the bottomland lakes are still intensively used by duck hunters. But, in time, these lakes will become so shallow that they cannot be navigated by boat, and the bottoms so soft that they cannot be waded. At that time, they will no longer be useable for duck hunting.

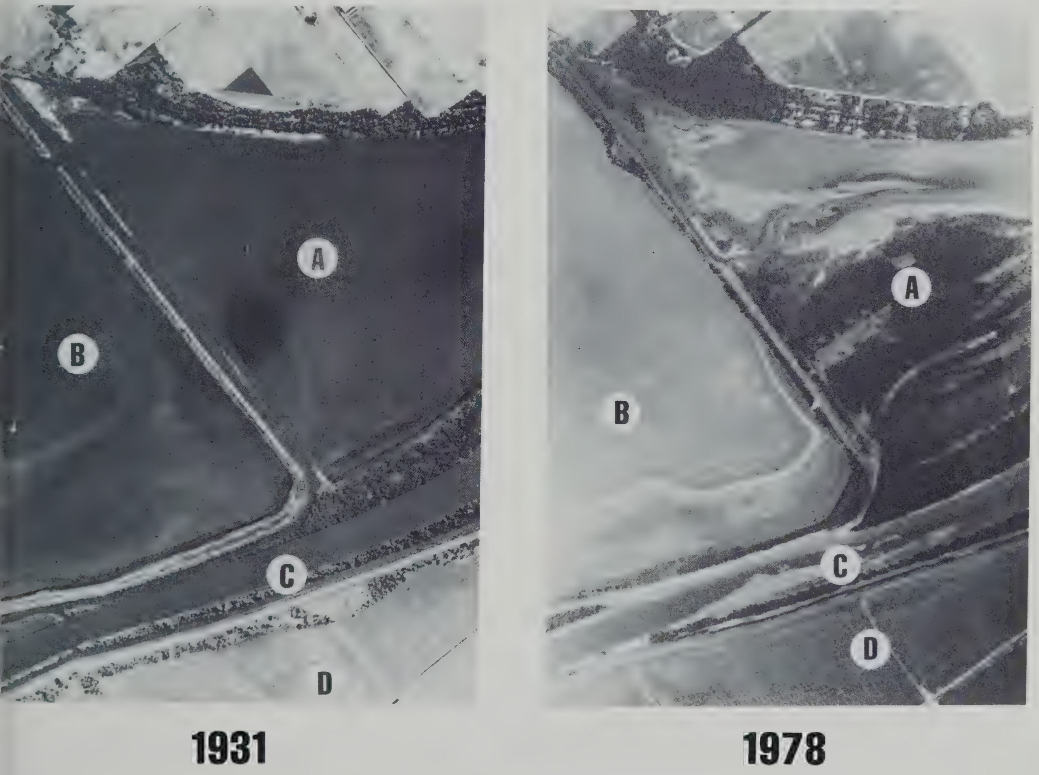
Upper Peoria Lake should be especially singled out for attention. It is the most important recreational lake in central Illinois, especially for Peoria, one of the state's largest cities. Peoria Lake is the largest lake in the Illinois Valley, and since the days of Pere Marquette and Joliet it has undoubtedly been the deepest. Yet, if we employ the sedimentation rates from 1965 to 1976, Upper Peoria Lake may lose approximately half of its volume by the year 2000 (Table 15) when its average depth would be about 0.5 m (1.6 feet). At that depth, water-related activities will become ncreasingly restricted. The river channel that passes hrough the lake will be less affected by sedimentation, ecause towboats continually resuspend and move the ediments in the channel bed laterally and downstream.

The "half-life" projections based upon sedimentation ates for earlier time periods indicate longer lives than do half-life" calculations for more recent periods. For examle, consider the "half-life" values with the corresponding ime periods: Upper Peoria—90 years for 1903–1965 and 4 years for 1965–1976, and Meredosia Lake—115 years for 903–1956 and 93 years for 1956–1978 (Table 15).

Using the proportion of lake basin filled with sediments uring the 1903–1975 period, Lee & Stall (1976) calculated hese longevities for two Illinois Valley lakes: Depue 33 ears and Meredosia 90 years. Lee (1976) projected the xpected life of Lake Chautauqua at 92 years. Their alculations were based on a constant amount of sediment egardless of the lessening depth or changing sedimentation ates during the 1903–1975 period.

Sediments filling in the bottomland lakes of the Illinois Valley are being transported to the main stem of the river largely from the drainage basins of tributary streams. Sediments originate from bank erosion, erosion of bluff areas, and sheet erosion of prairie farm lands. Lee & Stall's (1976:25) calculation of the annual sediment load from the basins of tributary streams carried into the main stem of the Illinois River and deposited in the lakes and floodplain approximates the annual amounts of sediment that we determined for the lakes of the Illinois Valley (Table 14). Thus, the general source of the sediments has been identified. But once in the Illinois River, other factors affect sedimentation.

The deposition of sediments in the Illinois River since 1910 has probably been almost doubled because drainage and levee districts have removed nearly half of the floodplain from inundation by the river. Fig. 10 shows Thompson Lake Drainage and Levee District (which drained Thompson Lake near Havana), the main stem of the river, Lake Chautauqua, and Quiver Lake. The removal of such a large segment of the floodplain increased flood heights,



1931 1978

Fig. 10.—Aerial views of the Illinois River valley approximately 8 km north of Havana in 1931 (left) and 1978 (right). Designated areas are Quiver Lake A); Lake Chautauqua, a national wildlife refuge, (B); Illinois River (C); and Thompson Lake Drainage and Levee District (D). Note the extensive area of uiver Lake (A) that had been filled by sedimentation by 1978. Thompson Lake Drainage and Levee District (D) converted famous Thompson and Flag kes to agricultural fields in 1921.

which in turn increased sedimentation rates as a result of the water depth-sedimentation syndrome elucidated earlier (Fig. 7, 8, 9).

The bottomland lakes serve as an important adjunct to the river as a floodway. Because sedimentation is reducing the depths of these lakes, their capacity to conduct flood waters through or to store water in their basins is being further curtailed. Thus, the magnitude of flood heights will rise and the frequency of flooding will increase as the bottomland lakes fill with sediments and eventually become bottomland forests. The filling of Quiver Lake and the resulting growth of willows and cottonwoods (Fig. 10) is illustrative of the future of these lakes and the manner in which their use as a floodway will diminish with the passing of time.

The resuspension of sediments by the passage of towboats in the Illinois River also adds appreciably to the sediments entering certain bottomland lakes. Near the mouth of the Illinois River (mile 3.0) tow traffic in 1977 increased the sediment volume entering backwater areas by an estimated 31.2 percent (Simons et al. 1981:4.28). They postulate that unconstrained river traffic will increase the volume of sediment to 46.8 percent above the natural volume entering backwater areas by the year 2000.

It should be emphasized that these sediments initially entered the river almost entirely from the erosion of upland soils and tributary stream banks. The resuspension of sediments by towboat traffic is a problem of secondary importance. The primary problem is the erosion of Illinois farmlands.

Peoria Lake is filling most rapidly at its upper end, the area nearest to the entrance of the river channel at Chillicothe. This filling is probably related to the reduction of river currents by about one-third by the Peoria Navigation Dam, resulting in greater deposits of sediments above the dam. Moreover, it is the only lake through which the river channel flows, subjecting the lake to a continuous load of sediments. The other bottomland lakes are lateral to the river channel and receive sediments largely during periods of inflow from the rising river or bank overflow.

In the early 1900's, the Illinois Valley had few equals in the nation as a fish and wildlife paradise. It has since been severely impacted by man, and it will lose its bottomland lakes if the sedimentation problem is not resolved in the next two decades. Unless current abusive land practices are abated, there is little hope that the bottomland lakes will be a useable recreational area for more than a few decades. The most feasible alternative is to use selected drainage and levee districts for both flood control and recreation, as proposed by Walraven (1950). An increase in diverted water from Lake Michigan would be advantageous if adapted to seasonal needs. However, the resuspension of soft bottom sediments would reduce the potential value of such a measure.

SUMMARY

1. Early in this century, man briefly enhanced the fish and waterfowl resources of the Illinois Valley by doubling the surface area of its bottomland lakes by diverting La Michigan water into the Illinois River.

2. Between 1909 and 1922, drainage and levee distri were constructed which drained almost half of the existi bottomland lakes. By removing about half of the floodpl from inundation by the river, drainage and levee distri have increased flood heights and the deposition of se ments on the remaining lakes and unleveed floodplain the Illinois Valley.

3. We estimated a total surface area of approximate 27,400 ha (67,700 acres) and a volume of 170,019,600 r (137,900 acre-feet) for the bottomland lakes in the Illinc River valley from Utica to Grafton for the period of 1976 1979.

4. Because sedimentation fills in deep water at a fast rate than it fills shallow water, bottomland lakes now a uniform, platter-shaped basins that have a low volume-t surface-area ratio.

5. At normal water level, bottomland lakes abo Upper Peoria Lake in Peoria Navigation Pool average or about 0.52 m (1.7 feet) in depth. Lakes in La Gran Navigation Pool average 0.54 m (1.8 feet), and those Alton Navigation Pool average 0.61 m (2.0 feet) in dept Upper Peoria Lake averages 0.98 m (3.2 feet) in depth an along with Lower Peoria Lake, is the deepest in the Illinc Valley.

6. In the last two decades sedimentation rates ha risen to alarming levels as agricultural practices ha resulted in increasing soil erosion in the Illinois Vall watershed. It has been calculated that the annual sedime loss in the Illinois River Basin amounts to 25 million metr tons (27.6 million tons). About 14 million metric tons (15 million tons) are deposited each year in Illinois Valley lak and the unleveed floodplain, and 11 million metric to (12.1 million tons) are transported into the Mississip River.

7. The deposition of sediments in the bottomland lak is dynamic, because the annual rate lessens as the lak become shallower. Therefore, to approximate when selecte lakes may lose half of their current average depths, a "hal life" equation was used to adjust for the constantly lessenir water depths.

8. A sedimentation time frame of 1903 to 1978 provid estimated "half-life" projections of the larger lakes: Ser achwine, 91 years; Billsbach, 63; Upper Peoria, 82; Beeb 127; Grand Island lakes, 72; Meredosia, 119; and Swan, 11 However, a more current time frame results in shorte "half-life" projections: Upper Peoria, 24 years, based upo the sedimentation rates of 1967 to 1976; Lake Chautauqu 76 years, using the 1926 to 1950 sedimentation rate and 6 years with the 1950 to 1976 sedimentation rate; Meredosi 93 years, using the 1956 to 1978 sedimentation rate.

9. Especially tragic is the short recreational life pre dicted for Upper Peoria Lake. As the largest and mos intensively used lake for recreation in central Illinois, it loss will be the greatest of all.

10. Only a reduction in soil erosion will extend the lif of Illinois Valley bottomland lakes. The only alternative i to convert some drainage and levee districts to flood storag and conservation and recreation use.

REFERENCES CITED

ellrose, Frank C., Richard E. Sparks, F. L. Paveglio, Jr., D. W. Steffeck, R. C. Thomas, R. A. Weaver, and D. Moll. 1977. Fish and wildlife habitat changes resulting from the construction of a nine-foot navigation channel in the Illinois Waterway from La Grange Lock and Dam upstream to Lockport Lock and Dam. U.S. Army Corps of Engineers District, Chicago. 150 p.

———, Fred L. Paveglio, Jr., and Donald W. Steffeck. 1979. Waterfowl populations and the changing environment of the Illinois River valley. Illinois Natural History Survey Bulletin 32:1–54.

utts, T. A. 1974. Measurements of sediment oxygen demand characteristics of the upper Illinois waterway. Report of Investigation 76. Illinois State Water Survey, Urbana. 32 p.

ickerson, Ray C. 1971. Inventory of Illinois drainage and levee districts. Illinois Department of Business and Economic Development. 955 p.

reenfield, R. E. 1925. Comparison of chemical and bacteriological examinations made on the Illinois River during a season of low and a season of high water—1923–1924. Illinois State Water Survey Bulletin 20:9–33.

avera, S. P., F. C. Bellrose, H. K. Archer, F. L. Paveglio, Jr., D. W. Steffeck, K. S. Lubinski, R. E. Sparks, W. U. Brigham, L. Coutant, S. Waite, and D. McCormick. 1980. Projected effects of increased diversion of Lake Michigan water on the environment of the Illinois River valley. U.S. Army Corps of Engineers, Chicago District. XXV + 550 p. + appendices.

linois Division of Waterways. 1956. Maps of Meredosia Bay.

———. 1969. Report for recreational development: Illinois River backwater areas. Appendix maps. 89 p.

ofoid, C. A. 1903. Plankton studies. IV. The plankton of the Illinois River, 1894–1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. Illinois State Laboratory of Natural History Bulletin 6:95–629.

ee, Ming T. 1976. Sediment deposition of Lake Chautauqua, Havana, Illinois. Unpublished Xeroxed report.

———, and Nani G. Bhowmik. 1979. Sediment transport in the Illinois River. Illinois State Water Survey Contract Report 218 prepared for the Illinois Division of Water Resources. 49 p.

———, and John B. Stall. 1976. Sediment conditions in backwater lakes along the Illinois River. Illinois State Water Survey Contract Report 176. 73 p.

———, and ———. 1977. Sediment conditions in backwater lakes along the Illinois River—Phase 2. Illinois State Water Survey Contract Report 176. 63 p.

ills, Harlow B., William C. Starrett, and Frank C. Bellrose. 1966. Man's effect on the fish and wildlife of the Illinois River. Illinois Natural History Survey Biological Notes 57. 24 p.

Mulvihill, W. F., and L. D. Cornish. 1929. Flood control report: an engineering study of the flood situation in the state of Illinois. Illinois Division of Waterways. 402 p.

Richardson, Robert E. 1921. The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: Its valuation; its sources of food supply; and its relation to the fishery. Illinois State Natural History Survey Bulletin 13:363–522.

Simons, D. B., R. M. Li, Y. H. Chen, S. S. Ellis, and T. P. Chang. 1981. Investigation of effects of navigation traffic activities on hydrologic, hydraulic, and geomorphic characteristics. Working Paper 2 for Task D submitted to Upper Mississippi River Basin Commission.

Sparks, Richard E., and William C. Starrett. 1975. An electrofishing survey of the Illinois River, 1959–1974. Illinois Natural History Survey Bulletin 31:317–380.

Starrett, William C. 1972. Man and the Illinois River. Pages 131–169 *in* R. T. Oglesby, C. A. Carlson, and J. A. McCann, eds., River ecology and man. Academic Press, Inc., New York.

Steffeck, D. W., F. L. Paveglio, Jr., F. C. Bellrose, and R. E. Sparks. 1980. Effects of decreasing water depths on the sedimentation rate of Illinois River bottomland lakes. Water Resources Bulletin 16:553–555.

Upper Mississippi River Comprehensive Basin Study Coordinating Committee. 1970. Upper Mississippi River comprehensive basin study. Vol. 3. Appendix G, Fluvial sediment.

U.S. Army Corps of Engineers. 1933. Illinois and Des Plaines Rivers from mouth of the Illinois River to Lockport, Illinois. U.S. Engineers Office, Chicago, Illinois.

———. 1965. Illinois Waterway, Peoria Pool 1965 soundings. Peoria Area Office.

———. 1976. Illinois Waterway, Peoria Pool 1976 soundings. Peoria Area Office.

———. 1979. Quantitative report. Upper Mississippi and lower Illinois rivers. Pools 24, 25, and 26. Terrestrial and aquatic land use and habitat change as a result of the nine-foot channel project. St. Louis District.

U.S. Department of Commerce and Labor. 1911. Special Reports. Fisheries of the United States 1908. Government Printing Office, Washington, D.C. 324 p.

Vanoni, V. A., ed. 1975. Sedimentation engineering. American Society of Civil Engineers Manuals and Reports on Engineering Practice 54. 745 p.

Walraven, W. B. 1950. Potential conservation areas along the Illinois River as a part of flood protection. Illinois Department of Conservation. 80 p.

Woermann, J. W. 1902–1904. Map of the secondary triangulation system of the Illinois and Des Plaines Rivers from Chicago, Illinois, to the mouth of the Illinois River. Corps of Engineers, Chicago Office, U.S. Army.

US ISSN 0073-490X

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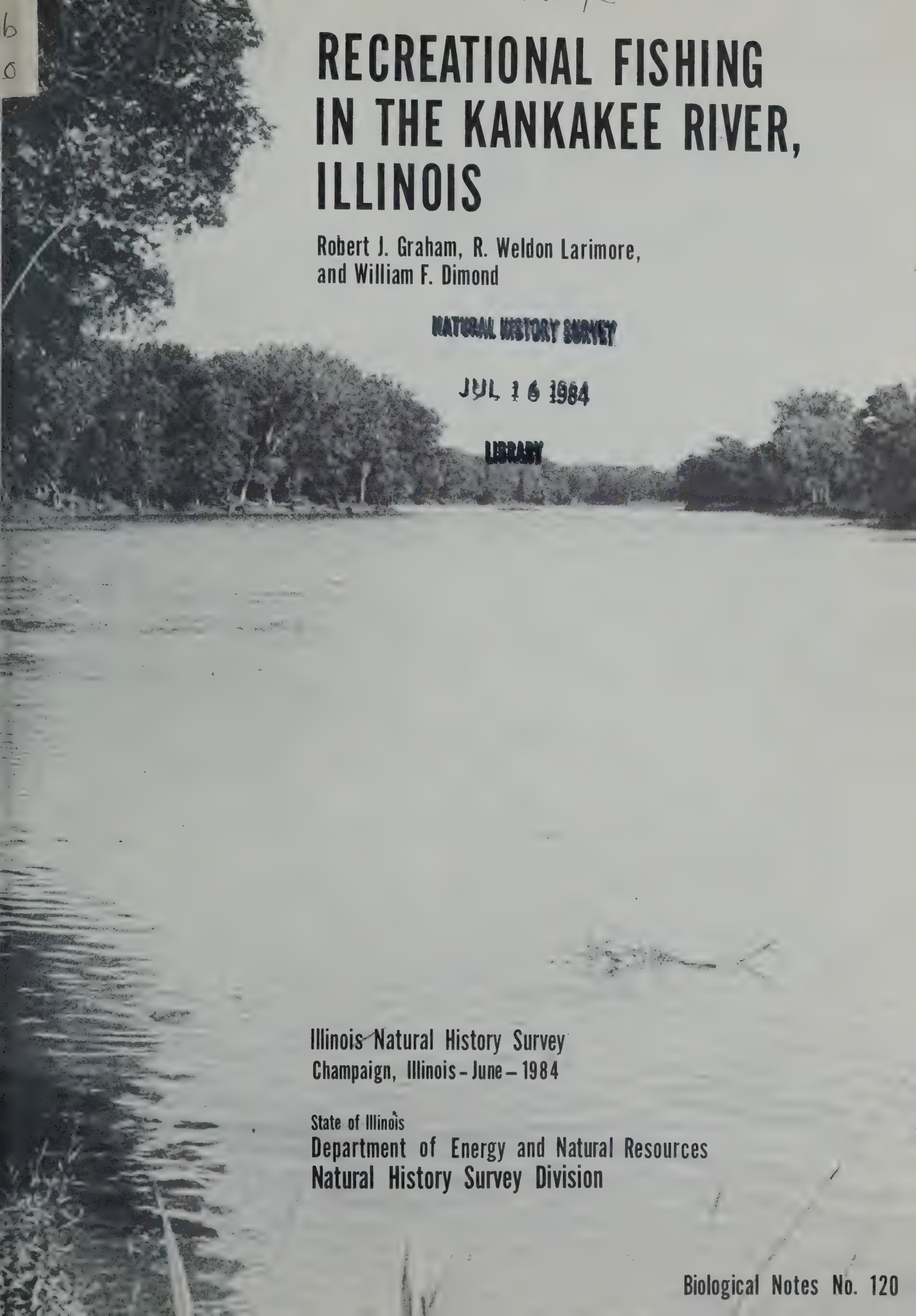

RECREATIONAL FISHING IN THE KANKAKEE RIVER, ILLINOIS

Robert J. Graham, R. Weldon Larimore,
and William F. Dimond

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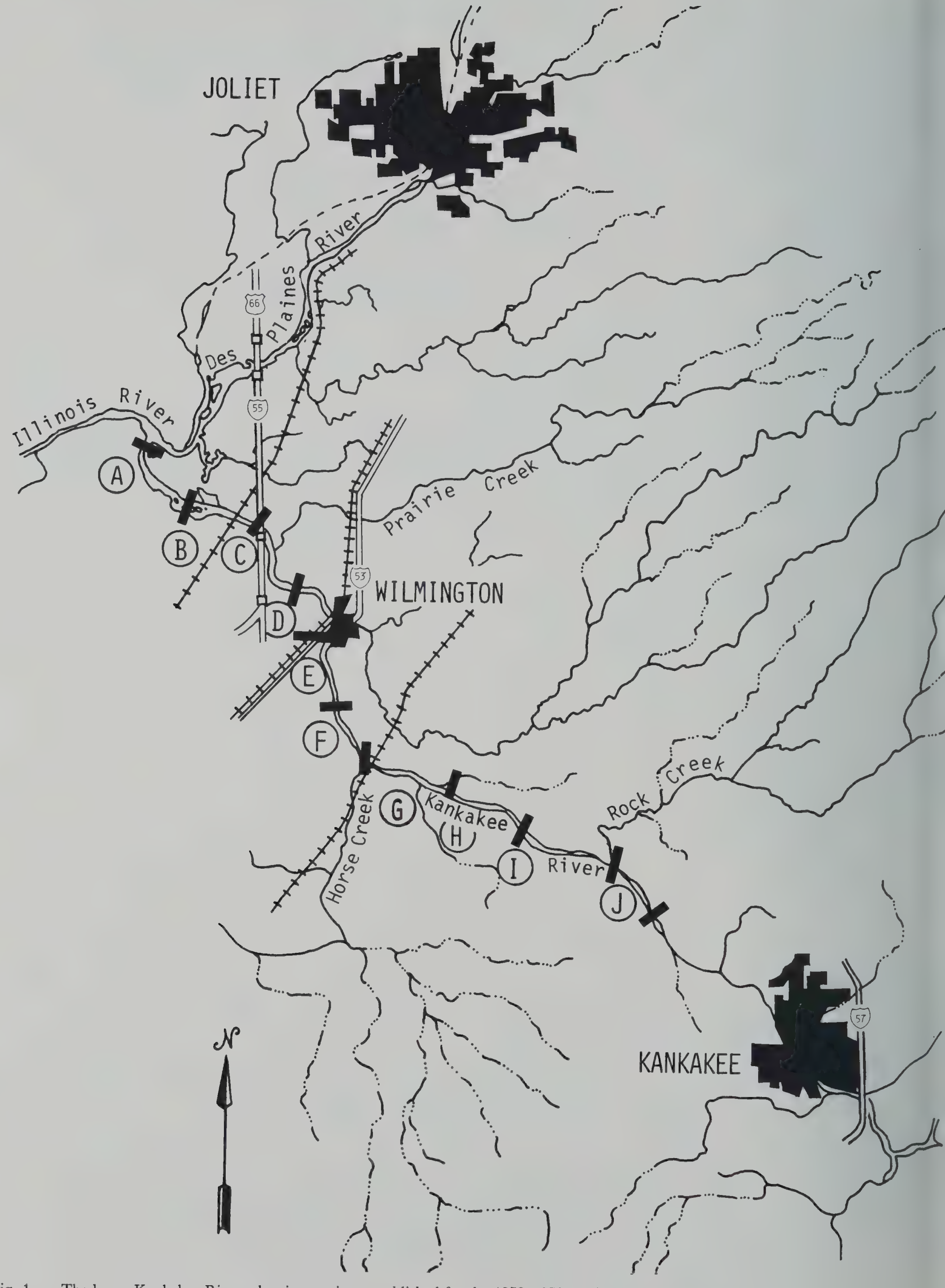

Fig. 1. — The lower Kankakee River, showing sections established for the 1978–1979 creel survey.

Cover photograph by Thomas Skelly.

Recreational Fishing in the Kankakee River, Illinois

Robert J. Graham, R. Weldon Larimore, and William F. Dimond

ABSTRACT

A 2-year creel survey was conducted on a 40-km ach of the lower Kankakee River during 1978 and 1979. ishing effort averaged 3,823 man-hours per km per year. lthough most fishing effort was not expended in pursuit any particular species, effort directed toward channel tfish and smallmouth bass was high relative to that rected toward other species. The mean annual catch te for all species was 0.13 fish and 56.7 g of fish per an-hour of fishing effort for an estimated total harvest of 9 fish weighing 217 kg per km per year. Most fisher- en traveled 41–80 km to fish the river and then general- still-fished. Trotline fishermen were individualistic in ethods employed and in success, making significant ntributions to annual fishing effort and catch. The ver's diverse habitats, high water quality, and ac- ssibility account for its importance as a recreational hing stream.

INTRODUCTION

Recreational fishing has rapidly increased in Illinois ring the past decade, paralleling projected increases in pulation and fishing license sales (Baur & Rogers 1983) d creating a critical need to evaluate fisheries resources. e need is especially acute for running waters. More an 30 percent of Illinois fishing trips in 1980 were to eams (Baur & Rogers 1983), and a nationwide census fishing (U.S. Department of the Interior and U.S. partment of Commerce 1982) revealed that 43 percent all anglers fished in rivers or streams in 1980. In spite this intense use, few studies have been made of the rvest of fish from warmwater streams.

The Kankakee River in northeastern Illinois is near eral metropolitan areas and is intensively used for creation. A survey of recreational fishing was conducted determine who fishes the river, what they catch, and at determines their success. More specifically, the ob- tives of the survey were to determine the (1) numbers, es, and efficiency of fishermen, (2) the seasonal and nual harvest, and (3) the catch rate, i.e., fish caught per n-hour of fishing. The survey was conducted on the ver river (Fig. 1) during 1978 and 1979 as part of a project designed to evaluate the effects of the construction of Commonwealth Edison's Braidwood Nuclear Generating Station on the river's biota and water quality. This study was made during a period of construction activity that had little effect on the river.

The Kankakee River flows westward 239 km from its source in northwest Indiana, draining 13,650 km^2. At Wilmington, Illinois, near its mouth, the mean annual discharge is 116 m^3/second (range: 6–2,150 m^3/second) (U.S. Geological Survey 1981), and Fig. 2 shows the seasonal discharge patterns during the 2 survey years. A 40-km reach of the lower river (Fig. 1) flowing through Kankakee, Will, and Grundy counties in northeast Illinois was included in the creel survey. Alternating riffles, islands, and pools typify the stream habitats, with near-surface bedrock controlling the hydrography and distribution of bottom materials. The upper sections of the study area (16 km) are typified by gravel-cobble substrate with numerous riffles, shallow pools, and small islands; the middle sections (14 km) by moderately deep (<3 m), silted pools separated by extensive runs of solid bedrock; the lower sections (10 km) near the river's confluence with the Des Plaines River by generally wide, deep, heavily silted waters (>3 m deep). Two low dams near the town of Wilmington interrupt the succession of stream habitats. Clustered residential areas separated by undeveloped woodlands characterize both banks. Four major tributaries not included in the survey enter the river within the study area.

The river's fish community is diverse; Sule et al. (Sule, M. J., D. D. Myrick, T. M. Skelly, S. M. Pescitelli. 1980. Adult and juvenile fishes of the Kankakee River and Horse Creek. Pages 6-1–6-374 *in* Construction and preoperational monitoring program for the Kankakee River, Braidwood Station. Third annual report. Illinois Natural History Survey, Urbana, IL) collected a total of 72 fish species from a 3-km reach within the study area between 1977 and 1979 and noted that many of the species collected are known for their intolerance of silty or polluted conditions. Three major metropolitan areas (Chicago, Joliet, and Kankakee) and many smaller communities are located within 80 km of the study area. Numerous public and private roads adjacent to both banks provide good access to the stream.

The only legal restrictions on angling in the Kankakee River apply to the black bass (limit of six fish), northern pike (three fish of 24 inches or longer), and walleye-sauger (six fish). Each fisherman may have two poles, trotlines, throw lines, or other legal devices not exceeding 50 hooks in total. Two untagged sport fishing devices are allowed; additional devices or devices left unattended must be tagged with the angler's name and address. No commercial fishing is permitted.

This paper is published by authority of the State of Illinois and is a tribution from the Section of Aquatic Biology of the Illinois Natural tory Survey. Robert J. Graham is a former Research Assistant, Dr. Weldon Larimore is an Aquatic Biologist, and William F. Dimond is pecialist in Aquatic Biology in the Section of Aquatic Biology.

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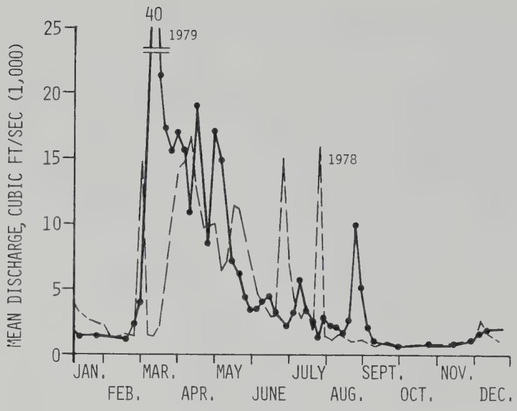


Fig. 2. — Five-day mean discharge of the Kankakee River near Wilmington, Illinois, during 1978 and 1979 as recorded by the U.S. Geological Survey.

METHODS

The survey method employed was a modification of that outlined by Starrett et al. (1963). The 40-km census area was divided into 10 sections of approximately equal length (Fig. 1). Although varying considerably through the 40-km reach, the stream averaged 197 m wide, creating sections of approximately 79 ha (195 acres). The sections were labeled alphabetically (A–J) from downstream to upstream. A stratified random sampling schedule was designed to survey all sections equa among days of the week and hours of the day. T schedule was based on an arbitrarily chosen 15-ho fishing day and an 8-day working week that sampled o or two sections per day for 5 consecutive days, allowed day for supplementary contacts, and provided 2 co secutive days off for the creel clerk. This schedule r quired 128 days to complete and was performed twi each survey year. The 1978 survey year began 26 Mar and ended 4 December. The 1979 survey year began March and ended 6 December. The December–Februa period was omitted because of greatly reduced fishing ar dangerous ice conditions.

Surveys of each section consisted of a progressi count and fisherman contacts. For the progressive coun the creel clerk moved through a section as rapidly as poss ble, counting and categorizing those fishing as boa bank, or wading fishermen. Fisherman contact data we recorded from those who had been fishing for 0.5 hour more in the section being surveyed. These data include observations by the creel clerk of fishing methods an catch and interviews with fishermen to obtain backgroun data, the total number of hours fished up to the time contact, and the species sought. Fishermen with n preference as to species sought were assigned to "general" category. Reports of fish released by fisherme were not recorded, since identifications of the fish we often uncertain.

During 1978, supplementary contact data we gathered weekly by stationing the creel clerk in one se tion for several hours in an attempt to contact fisherme

Table 1. — Kinds of fishing effort on sections (lettered from downstream to upstream) of the lower Kankakee River during the 1978 and 19 survey years.

Fishing Category	Distribution of Fishing Effort (Man-hours per km per Year) by River Section										
	A	B	C	D	E	F	G	H	I	J	Mean
					1978						
Bank	480	3,526	2,564	9,430	416	577	192	833	3,076	1,897	2,299
Wading	0	0	488	1,960	32	0	0	0	515	32	299
Boat	352	1,377	323	0	97	129	450	256	32	64	308
Total	*832*	*4,903*	*3,335*	*11,390*	*545*	*706*	*642*	*1,089*	*3,623*	*1,993*	*2,906*
					1979						
Bank	1,138	4,501	4,282	16,792	1,580	464	532	1,139	3,267	4,130	3,782
Wading	0	562	99	3,530	32	0	0	263	196	224	491
Boat	1,030	1,278	596	99	0	631	464	302	196	67	466
Total	*2,168*	*6,341*	*4,977*	*20,421*	*1,612*	*1,095*	*996*	*1,704*	*3,659*	*4,421*	*4,739*
					1978–1979 Pooled Mean						
Bank	809	4,013	3,423	13,111	998	520	362	986	3,172	3,014	3,041
Wading	0	281	274	2,745	32	0	0	132	356	128	395
Boat	691	1,328	460	50	49	380	457	279	114	66	387
Total	*1,500*	*5,622*	*4,157*	*15,906*	*1,079*	*900*	*819*	*1,397*	*3,642*	*3,208*	*3,823*

aving the river who had completed their day's fishing. n 1979, weekly supplementary contact data were col- cted by a roving creel clerk who traversed all sections, ontacted all fishermen encountered, and obtained infor- ation, in addition to the 1978 questions, concerning the rimary purpose of the fisherman's visit, his selection of a articular fishing site, and the number of other sections he ad previously fished within the study area.

Fishing effort was calculated from progressive counts sing the mean-count method of Lambou (1961). Distri- ution of fishing effort, catch per unit of fishing effort, nd calculated total projected catch according to species ere determined by using procedures detailed by Starrett al. (1963). The percentage of successful fishing parties ne or more fishermen sharing a common creel contain- g one or more fish) was determined as recommended by ambou (1966).

Because trotline and limbline fishermen are secretive nd nocturnal in their fishing habits, special efforts were ade to contact these fishermen in 1979. Additional con- cts were solicited by attaching to the fishing lines cards earing a brief explanation of the creel survey, a state- ent of confidentiality, and a local telephone number to ll. A total of 89 trotlines and 21 limblines were tagged 26 June and 4 August.

RESULTS

shing Effort

Fishing effort expended by contacted fishermen com- ised 2.3 percent of annual projected fishing effort for e 1978 survey year and 1.4 percent for the 1979 survey ar, or 1.7 percent of total projected fishing effort for the mbined years.

Fishing effort within the study area during the 1978 d 1979 survey years averaged 3,823 man-hours per km r year (Table 1). Observed annual fishing effort in 1979 s 61.3 percent greater than in 1978; this apparent in- ease may have been influenced by the more frequent use of a canoe for progressive counts during low-water periods, probably yielding increased accuracy in progressive counts. However, the use of the canoe may have had little influence on estimates of total fishing, for canoeing was generally limited to relatively inaccessible areas that received little fishing pressure. Despite the increase in estimated fishing effort in 1979, distributions of effort by categories of fishermen, sections fished, species sought, and sampling schedules completed during the first and second halves of both survey years were consistent between years.

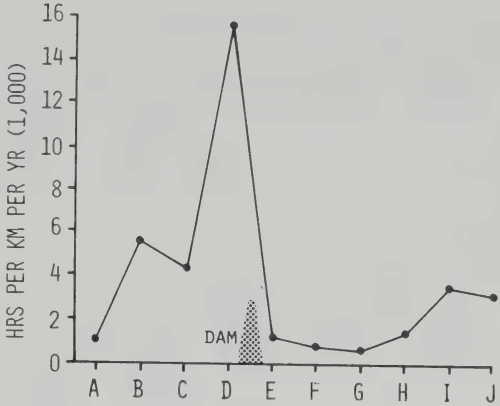
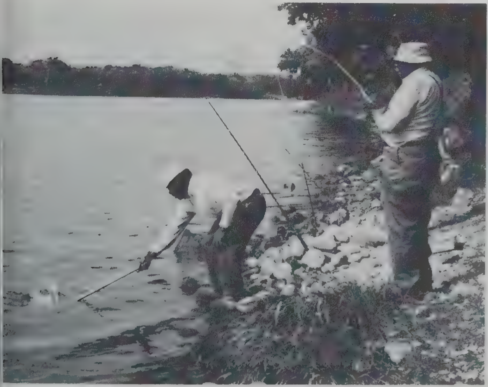


Fig. 4. — Distribution of fishing effort through sections of the lower Kankakee River study area. Sections are lettered from downstream to upstream.



3. — Many hours are spent bank fishing.

Bank fishermen (Fig. 3) accounted for 79.1 and 79.8 percent of annual fishing effort in 1978 and 1979, respectively, dominating all sections except G in 1978 and F in 1979, both above Wilmington dam, where private lands limit public access. Wading fishermen expended 10.3 and 10.4 percent of the effort in 1978 and 1979, respectively, with the greatest pressures on sections C, D, and I in 1978 and sections B, D, and H in 1979. These intensively used sections (B, C, and D below the Wilmington dam and H and I in the riffles and around the islands of Kankakee River State Park) are partly or wholly public property and

Fig. 5. — Wilmington dam attracts many fishermen.

have good roads closely paralleling both sides of the stream. During both years, the greatest number of hours was spent in Section D (Fig. 4), where fishermen waded the shallow tail waters below the Wilmington dam (Fig. 5). Fishermen also waded to avoid crowded areas or to gain access to isolated areas. Boat fishermen accounted for 10.6 percent of the fishing effort in 1978 and 9.8 percent in 1979. Boat fishing was limited by access restrictions, the Wilmington dam between sections D and E, and the shallow, rocky nature of the river. Direct boat access (excluding canoes) exists only in sections B (below Wilmington) and I (in the Kankakee River State Park), except for persons living along the river's banks. Docking facilities in section G provide access for private club members to sections F, G, and H above Wilmington, where private ownership limited public entry. High water levels during spring and summer reduced the limitations on boat fishing imposed by shallow water. All sections of the lower Kankakee River are accessible by canoe, though few fishermen were observed using them. Water skiing discouraged many summer boat fishermen from using sections A, B (above the confluence with the Des Plaines River), and G (with many private clubs and cottages).

Table 2. — Primary purpose of visit, reason for site selection, and number of sections fished by 869 fishermen contacted during the 1979 survey year on the lower Kankakee River.

	Number	Percentage
Purpose of Visit [a]		
Fishing	639	74
Escape from pressure	114	13
Picnicking	33	4
Camping	17	2
Nature study	6	<1
Boating	4	<1
Other	65	7
Reason for Site Selection [a]		
Previous success	255	29
Easy access	189	22
Attractive spot	112	13
Advice of friends	105	12
Solitude	36	4
Press reports	31	4
Scenery	4	<1
Campsite	2	<1
Other	184	21
Number of Other Sections Fished		
0	603	69
1	161	18
2	72	8
3	15	2
4	11	1
5	2	<1
6	0	<1
7	0	<1
8	3	<1
9	2	<1

[a] Several fishermen gave more than one purpose or reason.

Table 3. — Numbers and weights (kg) of fishes caught by contac fishermen on the lower Kankakee River during the 1978 and 19 survey years.

Species	1978		1979	
	No.	kg	No.	kg
Carp *(Cyprinus carpio)*	68	53.859	70	46.774
Channel catfish *(Ictalurus punctatus)*	40	18.104	82	56.271
Shorthead redhorse *(Moxostoma macrolepidotum)*	26[a]	13.440	24	12.831
River redhorse *(Moxostoma carinatum)*	4[a]	4.251	25	14.545
Smallmouth bass *(Micropterus dolomieui)*	34	9.503	36	8.695
Golden redhorse *(Moxostoma erythrurum)*	10	7.709	12	8.531
Freshwater drum *(Aplodinotus grunniens)*	26	7.863	7	5.665
Rock bass *(Ambloplites rupestris)*	19	3.380	31	3.217
Silver redhorse *(Moxostoma anisurum)*	1	0.200	5	4.027
Northern pike *(Esox lucius)*	4	2.264	1	0.684
Black bullhead *(Ictalurus melas)*	8	0.813	14	1.125
Walleye *(Stizostedion vitreum)*	1	0.160	2	1.281
Quillback *(Carpoides cyprinus)*	1	1.350	. .	. . . .
Black redhorse *(Moxostoma duquesnei)*	. .	. . . .	3	1.290
Bowfin *(Amia calva)*	1	1.138	. .	. . . .
Longnose gar *(Lepisosteus osseus)*	. .	. . . .	1	0.876
Yellow bullhead *(Ictalurus natalis)*	3	0.563	2	0.300
Northern hog sucker *(Hypentelium nigricans)*	1	0.740	. .	. . . .
Longear sunfish *(Lepomis megalotis)*	2	0.037	12	0.428
White crappie *(Pomoxis annularis)*	. .	. . . .	4	0.429
Creek chub *(Semotilus atromaculatus)*	. .	. . . .	6	0.395
Bluegill *(Lepomis macrochirus)*	1	b	5	0.383
Green sunfish *(Lepomis cyanellus)*	3	0.100	6	0.282
Black crappie *(Pomoxis nigromaculatus)*	8	0.382	. .	. . . .
Stonecat *(Noturus flavus)*	2	0.290	2	0.082
Total	*263*	*126.146*	*350*	*168.111*

[a] A few river redhorse may have been misidentified as shorthead redhorse during the first part of the census.

[b] Weight not obtained.

Fishing effort tended to be concentrated in those sec-ons most accessible to the public. More than 75 percent f the annual fishing effort occurred in sections B, C, D elow Wilmington dam and sections I and J in Kankakee iver State Park (Fig. 4). Most (74 percent) fishermen ontacted in 1979 said that fishing was the primary pur-ose of their visit, followed by escape from pressure (13 ercent) (Table 2). Previous success and easy access ac-unted for 29 and 22 percent, respectively, of the reasons ven for the selection of a particular fishing site. Sixty-ine percent of the fishermen questioned fished one sec-on exclusively, and only 18 percent had previously shed two sections within the study area.

atch and Catch Rate

Twenty-five species of fishes were observed in the ssession of fishermen during the study (Table 3). The incipal species (numbers) caught by contacted fisher-en during both years were carp, channel catfish, small-outh bass, rock bass, and shorthead redhorse, whereas tch (biomass) was dominated by carp, channel catfish, orthead redhorse, river redhorse, and smallmouth bass. high percentage of these species was caught down-eam of the two low dams. All freshwater drum were ken in those lower sections (Table 4).

The majority (61 percent) of fishing effort during th years was not expended in pursuit of any particular ecies (Table 5). However, fishing effort directed toward annel catfish (20 percent), smallmouth bass (10 percent), and walleye (5 percent) was high relative to that expended on other species.

Fishing effort expended from mid-March through early August accounted for 70.8 and 68.2 percent of the effort in 1978 and 1979, respectively. The mean annual catch rate for all species for 1978 and 1979 combined was 0.13 fish and 56.7 g of fish per man-hour of fishing effort (Table 6). Many carp, redhorse, and stonecat were reportedly released. The numbers and grams of fish caught per man-hour of effort from mid-March through early August were greater than those of the period mid-August through early December both years (Table 6). Approximately 22 and 26 percent of all fishing parties contacted during the 1978 and 1979 survey years, respectively, were successful. Both years combined showed a 25-percent success ratio for the mid-March through early August period and a 20-percent success ratio for the period from mid-August through early December.

The projected catch for the 1978 and 1979 survey years averaged 472 fish weighing 217 kg per km per year (Table 7), which equals 23.8 fish weighing 11.0 kg per hectare, or 9.6 fish weighing 9.8 pounds per acre. The 1979 catch in terms of both numbers and biomass of fish caught was approximately twice that of 1978 due to increases in both fishing effort (Table 1) and catch per unit of fishing effort (Table 6).

Fisherman Profile

The fishing population was primarily composed of males between the ages of 11 and 50 years (Table 8) who

Table 4. — Numbers and weights (kg) of the eight most important species measured during the 1978 and 1979 creel surveys in each section ttered from downstream to upstream) of the lower Kankakee River.

	River Section											
Species	A	B	C	D	[Low Dams]	E	F	G	H	I	J	Total
Carp												
Number	12	35	14	66		2	3	1	. . .	. . .	5	138
Weight	6.34	20.51	7.71	52.49		0.65	6.34	0.64			5.96	100.64
Channel catfish												
Number	8	35	12	19		. . .	22	16	7	1	2	122
Weight	2.25	18.84	6.32	7.82			15.22	12.25	7.86	2.84	0.99	74.39
Shorthead redhorse												
Number	1	3	3	26		2	. . .	. . .	2	3	10	50
Weight	0.51	1.24	1.34	14.34		0.90			0.84	1.50	5.62	26.29
River redhorse												
Number	1	1	1	22		. . .	. . .	1	. . .	1	2	29
Weight	0.48	0.28	0.34	15.81				0.54		0.40	0.95	18.80
Smallmouth bass												
Number	. . .	2	7	38		2	. . .	9	1	2	9	70
Weight		0.28	1.84	10.24		0.31		2.28	0.84	1.01	1.41	18.21
Golden redhorse												
Number	. . .	1	. . .	17		. . .	. . .	. . .	1	1	2	22
Weight		0.13		12.16					0.93	1.22	1.80	16.24
Freshwater drum												
Number	2	11	4	16		. . .	. . .	. . .	. . .	. . .	. . .	33
Weight	0.53	3.65	4.72	4.64								13.54
Rock bass												
Number	. . .	2	. . .	38		1	. . .	. . .	4	3	2	50
Weight		0.29		4.52		0.13			0.31	0.96	0.40	6.61

Table 5. — Distribution of effort spent fishing for different species in the lower Kankakee River during the 1978 and 1979 survey years.

Species Sought	1978 Man-hours per km per Year	 Percentage	1979 Man-hours per km per Year	 Percentage	Mean Man-hours per km per Year	 Percentage
General	1,807	62	2,863	60	2,335	61
Channel catfish	550	19	989	21	769	20
Smallmouth bass	283	10	450	9	366	10
Walleye	119	4	241	5	180	5
Rock bass	91	3	41	<1	66	2
Crappie	24	<1	66	1	45	1
Carp	28	<1	31	<1	29	<1
Northern pike	2	<1	37	<1	20	<1
Panfish (all inclusive)	0	<1	13	<1	7	<1
Game fish (all inclusive)	0	<1	8	<1	4	<1
White bass	2	<1	0	<1	1	<1
Suckers	2	<1	0	<1	1	<1

still-fished using natural bait (Table 9). The majority (60 percent) of fishermen contacted resided in Cook County and many (50 percent) traveled between 41 and 80 km to fish the river, indicating that the Chicago metropolitan area was where most fishermen lived (Table 10). Fishermen who resided in Will County and those who traveled between 17 and 40 km were the second most abundant groups of fishermen contacted (31 and 22 percent, respectively), and most probably resided in the Joliet metropolitan area. Local fishermen (travelling 0–16 km) may have resided in Kankakee, southern Will, or Grundy counties; they were a relatively minor segment (13 percent) of the fishermen using the lower Kankakee River.

Though commercial fishing is prohibited on the Kankakee River, many fishermen employed trotlines and limblines. Creel clerks counted 171 trotline jugs, 10 trotlines without jugs, and 164 limblines during a 1-wee survey of the study area in 1979. These counts did nc represent the actual number of actively fished lines due t (1) incomplete counts as a consequence of advers weather conditions, (2) the fact that fishermen often abandoned their lines for indefinite periods throughout th course of the season, and (3) the submersion of trotline and limblines during periods of high water and for purposes of concealment.

Table 6. — Comparison of catch per man-hour of fishing effort by numbers and weights of fish recorded in sampling schedules completed during the first and second halves of the 1978 and 1979 survey years on the lower Kankakee River.

Year	Mid-March Early August No.	 Wt (g)	Mid-August Early Dec. No.	 Wt (g)	Entire Year[a] No.	 Wt (g)
1978	0.11	49.9	0.09	31.3	0.10	46.6
1979	0.14	67.8	0.13	49.2	0.14	63.0
Combined years [a]	0.13	59.6	0.10	38.7	0.13	56.7

[a] Based on pooled data.

Twenty-one different trotline fishermen were interviewed on 54 occasions in 1979. Two of these interview were the result of the survey card system. One limblin fisherman was contacted but refused to be interviewed Twenty of the trotline fishermen sought channel catfis exclusively. The frequency of baiting and checking line varied from once every hour to once every 3 days. Thes fishermen actively fished their lines for a period varyin from half a day to half a year. On several occasions cree clerks accompanied trotline fishermen when they checke their lines. Fish caught on these trips were weighed alon with others in the fisherman's live-box that had bee previously caught on trotlines (Table 11). Three of th fishermen interviewed claimed annual catches of channe catfish of well over 45 kg. Many carp, redhorse, stonecat and small (<250 mm) channel catfish were reportedl released. Although valid estimation of effort or catch wa impossible, it is probable that large numbers of channe catfish were taken by trotline during 1979.

DISCUSSION

The lower Kankakee River is popular with northeastern Illinois fishermen, attracting 3,823 hours o

Table 7. — Projected catch of fishes from the lower Kankakee River during the 1978 and 1979 survey years. Species are arranged in descending order of weight taken.

Species	1978		1979		Mean	
	No. per km per Year	Wt (kg) per km per Year	No. per km per Year	Wt (kg) per km per Year	No. per km per Year	Wt (kg) per km per Year
Carp	76	59.08	123	83.21	100	71.14
Channel catfish	44	19.86	147	100.10	96	59.98
Shorthead redhorse	29	14.74	43	22.82	36	18.78
River redhorse	3	1.28	43	25.88	23	13.58
Smallmouth bass	38	10.82	66	15.47	52	13.14
Golden redhorse	12	8.29	24	15.18	18	11.73
Freshwater drum	29	8.60	14	10.08	22	9.34
Rock bass	20	3.71	57	5.72	38	4.72
Silver redhorse	3	0.22	9	7.17	6	3.70
Northern pike	6	2.48	5	1.22	6	1.85
Black bullhead	9	0.89	24	2.00	16	1.44
Walleye	3	0.17	5	2.28	4	1.22
Quillback	3	2.29	0	0.00	2	1.14
Black redhorse	0	0.00	5	1.48	2	0.74
Bowfin	3	1.25	0	0.00	2	0.62
Longnose gar	0	0.00	5	1.18	2	0.59
Yellow bullhead	3	0.62	5	0.54	4	0.58
Northern hog sucker	3	0.81	0	0.00	2	0.40
Longear sunfish	3	0.04	24	0.76	14	0.40
White crappie	0	0.00	9	0.76	4	0.38
Bluegill	3	a	9	0.68	6	0.34
Creek chub	0	0.00	9	0.68	4	0.34
Green sunfish	3	0.11	9	0.52	6	0.32
Black crappie	9	0.60	0	0.00	4	0.30
Stonecat	3	0.32	5	0.15	4	0.24
Total	*305*	*136.17*	*640*	*297.86*	*472*	*217.02*

[a] Weight was not obtained.

Table 8. — Sex and age of fishermen contacted on the lower Kankakee River during the 1978 and 1979 survey years.

	1978		1979		Mean	
	No.	%	No.	%	No.	%
Sex						
Male	838	84	715	82	776	83
Female	163	16	154	18	158	17
Age						
1–10	64	6	42	5	53	6
11–20	194	19	143	16	168	18
21–30	239	24	192	22	216	23
31–40	185	18	165	19	175	19
41–50	136	14	128	15	132	14
51–60	101	10	86	10	94	10
60 +	82	8	113	13	98	10

Table 9. — Fishing methods and baits used by fishermen contacted on the lower Kankakee River during the 1978 and 1979 survey years.

	1978		1979		Mean	
	No.	%	No.	%	No.	%
Method						
Still	927	91	820	91	874	91
Cast	87	9	81	9	84	9
Troll	0	<1	2	<1	1	<1
Bait [a]						
Natural	904	83	771	74	838	78
Prepared	99	9	156	15	128	12
Artificial	97	9	108	10	102	10

[a] Some fishermen used more than one bait.

Table 10. — County of residence of fishermen contacted and distance traveled to fish on the lower Kankakee River during the 1978 and 1979 survey years.

		1978		1979		Mean	
		No.	%	No.	%	No.	%
County							
Cook		600	60	511	59	556	59
Will		297	30	282	32	290	31
Kankakee		63	6	48	6	56	6
Du Page		20	2	16	2	18	2
Grundy		14	1	1	<1	8	<1
La Salle		3	<1	0	<1	2	<1
Kane		2	<1	1	<1	2	<1
Livingston		1	<1	2	<1	2	<1
Champaign		0	<1	1	<1	0	<1
Christian		0	<1	1	<1	0	<1
Sangamon		0	<1	1	<1	0	<1
Out of state		1	<1	5	<1	3	<1
Distance							
Miles	km						
0–10	0– 16	151	15	97	11	124	13
11–25	17– 40	178	18	214	25	196	22
26–50	41– 80	460	46	474	55	467	50
51–75	81–120	207	21	75	9	141	15
76–99	121–158	4	<1	3	<1	4	<1
100 +	159 +	1	<1	6	<1	4	<1

fishing per kilometer (6,156 hours per mile or 79 hours per acre of water) during the 1978 and 1979 seasons. This fishing effort per unit of stream length is several times larger than those reported in comparable creel surveys (Fleener 1975; Funk & Fleener 1966, 1974; Harrison 1962). When expressed by area, 79 hours of fishing per acre per year in the lower Kankakee River falls within the range (53–111 hours) of 8 years of fishing records on the Big Piney River (Funk & Fleener 1974), is well above the range (31–54 hours) for 11 years on the Niangua River (Funk & Fleener 1966), and is below the range (107–190 hours) on Courtois Creek (Fleener 1975), all Missouri streams on which intensive surveys have been conducted. Although exceeded by the smaller Courtois Creek in fishing pressure per unit of surface area (per acre), the intense fishing pressure, when expressed by unit of length of stream (per kilometer), on the lower Kankakee River demonstrates its attraction and value as a recreational resource.

The importance of public access was emphasized by the distribution of fishing effort through the study sections. Those sections that received the greatest effort were accessible through state parks, conservation areas, or city parks (Fig. 4). Only one other section (H) had public access over state lands but received light fishing pressure, probably because it was inaccessible to automobiles. Sections E, F, and G were fished relatively little because most of the stream bank is private land. Easy access to an unfamiliar body of water plays an important part in the selection of a fishing site (Hewston & Franklin 1969), and areas with an assemblage of pleasing characteristics, i.e., parks, will attract more fishermen than drab, less inter-

Table 11. — Numbers and weights of fishes caught on trotlines by fishermen contacted on the lower Kankakee River during the 1979 survey year.

Species	Number	Weight (kg)
Channel catfish	42	30.42
Carp	1	4.15
Freshwater drum	1	2.67
Silver redhorse	3	2.63
Shorthead redhorse	1	0.65
River redhorse	1	0.61
Yellow bullhead	2	0.47
Smallmouth bass	1	0.35
Rock bass	1	0.24
American eel *(Anguilla rostrata)*	1	[a]
Total	*54*	*42.19*

[a] Weight was not obtained.

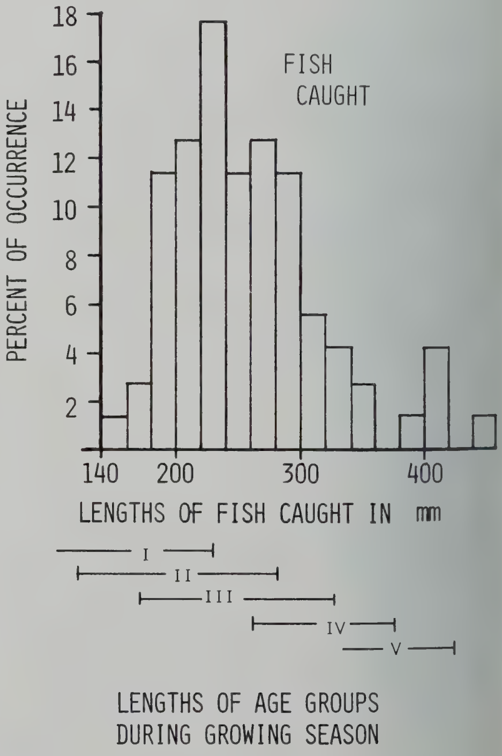


Fig. 6. — Total lengths (mm) of smallmouth bass caught and range in sizes of each year class in the river during the fishing season, including the smallest fish in the spring and the largest one in the fall.

sting ones (Zeller 1960). Most fishermen contacted were ither satisfied with the fishing conditions available or vere ignorant of access available in other sections on the ankakee.

Species composition of the 1978 and 1979 catch Table 3) accents the lower Kankakee River's diverse abitat and good water quality. The Kankakee River is onsidered one of the best channel catfish, smallmouth ass, and walleye streams in Illinois. It is the source of the resent Illinois state record walleye (14 pounds) and carp 42 pounds) and held the state smallmouth bass record ntil 1980, with a 5-pound, 15.5-ounce fish. The river's eputation for channel catfish and smallmouth bass was ubstantiated by the creel survey (Table 5). Smallmouth ass entered the creel at the small size of 140 mm and conributed most to the catch as 230-mm fish at age II and III Fig. 6). Although of special interest, only three walleye vere observed in the possession of fishermen during the tudy. There were many reports of good walleye catches n the early spring and late fall, but those catches were enerally in the upper reaches of the river between the ity of Kankakee and the Illinois–Indiana state line. In ne Des Moines River, a river similar to the lower ankakee River in many respects, Harrison (1962) egarded the walleye as a species mainly taken by pecialist fishermen.

Although fishermen enjoyed a diverse catch, the catch rate of only 0.12 fish per hour is low. The fish caught were large (436 g, or nearly a pound) compared with the 134-g fish taken in Courtois Creek (Fleener 1975), where 0.80 fish was caught per hour. Generally, warmwater streams with high catch rates produce large numbers of small sunfishes, unlike those streams yielding low numbers per hour, with the catch composed of large fish, especially catfish, carp, and suckers (Fig. 7). Bennett (1971) stated that catch rates of less than 50 g per man-hour of fishing effort were unsatisfactory to most fishermen, a criterion barely exceeded by lower Kankakee River fishermen.

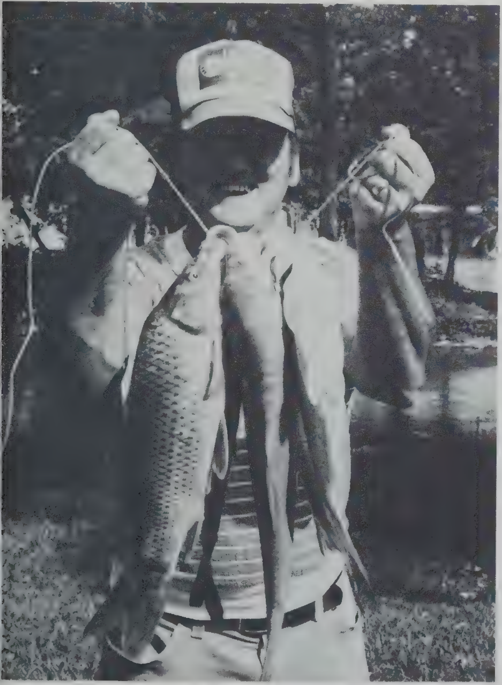


Fig. 7. — Large carp, catfish, and suckers make up much of the ngler's catch.

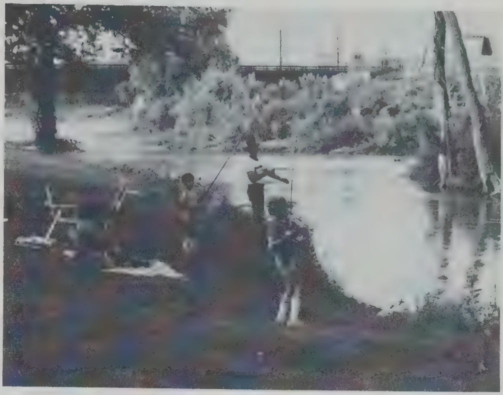


Fig. 8. — Family fishing is important where access is easy, as along the side channel in Wilmington Park.

Field observations suggested two factors that may have adversely influenced fishing success. First, conditions for good fishing on the lower Kankakee River are often of relatively brief duration because the river is subject to rapid fluctuations in turbidity and elevation due to heavy spring and summer rains, and these fluctuations are exacerbated by channelization of the upper reaches. Fleener (1975) described a similar situation that periodically virtually eliminated fishing in an Ozark smallmouth bass stream, but in his report, data from periods of poor conditions were excluded. Fishermen on the lower Kankakee River, especially those who traveled long distances, did not appear to time their visits to coincide with periods of favorable conditions. Thus, fishing effort exerted during poor conditions reduced fishing success.

A second factor that decreased fishing success was the lack of aptitude or skill of the average fisherman. Harrison (1962) reported that low catch rates persisted for 9 years in the Des Moines River despite large fish populations, concluding that the low catch rates were "largely the result of fishing techniques employed by *each* angler." An analogous situation existed on the lower Kankakee River. Many fishermen were not actively seeking fish. Rather, they selected one spot and stayed there or were engaged in other activities, such as picnicking with all members of the family (Fig. 8). Enjoyment of the total outdoor experience seemed to be the prime consideration

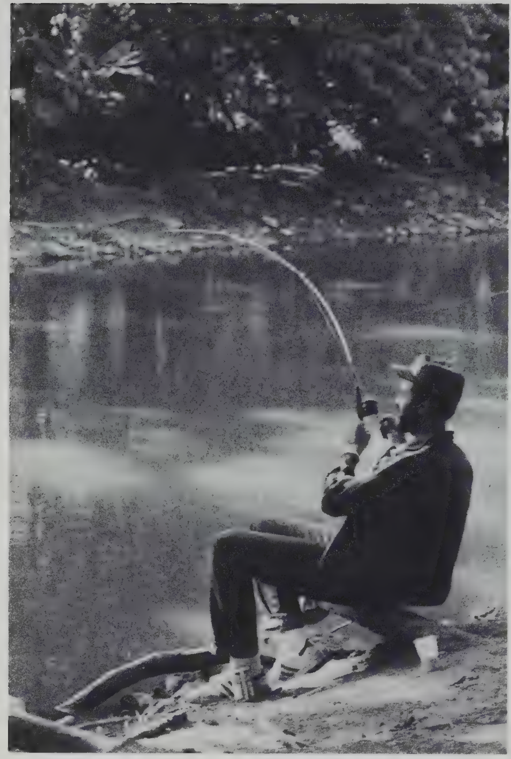


Fig. 9. — Mouths of tributaries, such as Rock Creek, shown here, are popular fishing places.

of most fishermen (McFadden 1969; Moeller & Engelken 1972; Weld 1977), because the majority were not seeking any particular species of fish and had fished only one or two sections of the study area.

Thus, the low catch per hour was caused by (1) few small fish in the catch, (2) the casual attitudes of many unskilled fishermen, (3) fishing during poor river conditions and unproductive seasons, (4) fish thrown back that were not counted, and (not mentioned above) (5) our poor nighttime catch records for catfish.

That fishing effort and success were greater in both years from mid-March through early August than it was during the mid-August through early December period (Table 7) may have been due to intensive exploitation of spring spawning runs and the prevalence of novice fishermen in late summer and fall. The Kankakee River and its tributaries are noted for excellent fishing during the spring (Nielson 1977). Although the tributary streams within the study area were not surveyed, the areas of their confluence with the river were. Fishermen often sought out these areas during spring spawning runs (Fig. 9). Tributary streams of the lower Kankakee River are extremely valuable as spawning habitats and nursery areas for several species of fish (Fig. 10), and fish and fishermen concentrate in these areas, increasing the probability of fishing success. Rupp's (1961) observation that most inexperienced fishermen lose interest as the season progresses would in part account for the decrease in fishing effort during the August through early December period.

Trotlines were generally used in an effort to harvest a large number of fish, particularly channel catfish, in a short period of time and were very effective when employed by experienced fishermen. Considering the paucity of literature concerning trotlines, this fishing method certainly merits further study.

Fig. 10. — Rock Creek, a tributary used by spawning bass and suckers.

Funk & Pflieger (1975) called attention to the distinctive characteristics and recreational opportunities offered by warmwater streams, often ignored or taken for granted. In view of its diverse fish population that includes many attractive sport species, proximity to major metropolitan areas, and extensive use by the fishing public, the lower Kankakee River must be considered a major outdoor recreational area.

ACKNOWLEDGEMENTS

The authors thank R. L. Holtz for field assistance, he Walter Sherry Chapter of the Izaak Walton League of America for the use of their grounds, and various members of the Illinois Natural History Survey for helpng in numerous ways. We also extend our thanks to Robert Gorden, Thomas Skelly, and Jana Waite of the Survey; Michael Sule, John A. Tranquilli, Bill A. Bertrand, and James Langbein of the Illinois Department of Conservation; and Leonard Durham of Eastern Illinois University for reviewing the manuscript. Most of the inancial support for this project was provided by the Commonwealth Edison Company, Chicago.

LITERATURE CITED

aur, R. J., and R. A. Rogers. 1983. 1980 Illinois sport fishing survey. Illinois Department of Conservation Special Fisheries Report 51. 47 p.

ennett, G. W. 1971. Management of lakes and ponds. 2nd ed. Van Nostrand Reinhold Company, New York. 375 p.

leener, G. G. 1975. Harvest of smallmouth bass and associated species in Courtois Creek. Pages 250–256 *in* R. H. Stroud and H. Clepper, eds. Black bass biology and management. Sport Fishing Institute, Washington, D.C.

Funk, J. L., and G. G. Fleener. 1966. Evaluation of a year-round open fishing season upon an Ozark smallmouth bass stream, Niangua River, Missouri. Missouri Department of Conservation, Division of Fisheries, D–J Series 2. 21 p.

———, and ———. 1974. The fishery of a Missouri Ozark stream, Big Piney River, and the effects of stocking fingerling smallmouth bass. American Fisheries Society Transactions 103:757–771.

———, and W. L. Pflieger. 1975. Courtois Creek, a smallmouth bass stream in the Missouri Ozarks. Pages 224–230 *in* R. H. Stroud and H. Clepper, eds. Black bass biology and management. Sport Fishing Institute, Washington, D.C.

Harrison, H. M. 1962. Creel census of Des Moines River fishermen in Boone, Dallas, and Polk counties, Iowa. Iowa Academy of Science Proceedings 69:277–295.

Hewston, J. G., and D. R. Franklin. 1969. Recreational use patterns at Flaming Gorge Reservoir, 1963–65. U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife Resource Publication 70. 80 p.

Lambou, V. W. 1961. Determination of fishing pressure from fishermen or party counts with a discussion of sampling problems. Southeastern Association of Game and Fish Commissioners Proceedings for 1961, 15:380–401.

———. 1966. Recommended method of reporting creel survey data for reservoirs. Oklahoma Fishery Research Laboratory Bulletin 4. 40 p.

McFadden, J. T. 1969. Trends in freshwater sport fisheries of North America. American Fisheries Society Transactions 98:136–150.

Moeller, G. H., and J. H. Engelken. 1972. What fishermen look for in a fishing experience. Journal of Wildlife Management 36:1253–1257.

Nielson, G. 1977. Here's a way to catch river walleyes. Fishing Facts 11:84–88.

Rupp, R. S. 1961. Measurement of potential fishing quality. American Fisheries Society Transactions 90:165–169.

Starrett, W. C., A. C. Lopinot, and L. Rock. 1963. 1962 Mississippi River sport fishing creel census procedures. Illinois Department of Conservation Division of Fisheries. 90 p.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. 1982. 1980 national survey of fishing, hunting, and wildlife-associated recreation. U.S. Government Printing Office, Washington, D.C. 156 p.

U.S. Geological Survey. 1981. Water resources data for Illinois. Vol. 2. Illinois River basin. Water year 1980. Water-Data Report IL–80–2. U.S. Government Printing Office, Washington, D.C. 468 p.

Weld, C. M. 1977. OY: an angler's perspective. Sport Fishing Institute Bulletin 286:4–5.

Zeller, H. D. 1960. Surveys for fisherman access in Georgia. Southeastern Association of Game and Fish Commissioners Proceedings for 1960, 14:239–242.

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